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Engineering News-Record

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Kill van Kull Bridge as it will look when completed. A 1675-ft. steel arch bridge connecting Bayonne, N. J., with Staten Island, N. Y. This new bridge will be about 25 ft. longer than the great arch bridge over Sydney Harbor in Australia and 700 ft. longer than Hell Gate Bridge.

IN THIS ISSUE: Design of the 1675-Foot Kill van Kull Arch Bridge—How Traffic Congestion Is Fostered by Control Measures—Tests of Frost Action on Concrete—Wanaque Aqueduct—Improving the Water-Works System of Evansville, Indiana—Concrete-Deck Timber Trestles on the Norfolk & Western Railroad—Sinking Open Caissons for the Foundation of a Tall Chimney—Abstract of the Board of Engineers' Report on the Boulder Canyon Project

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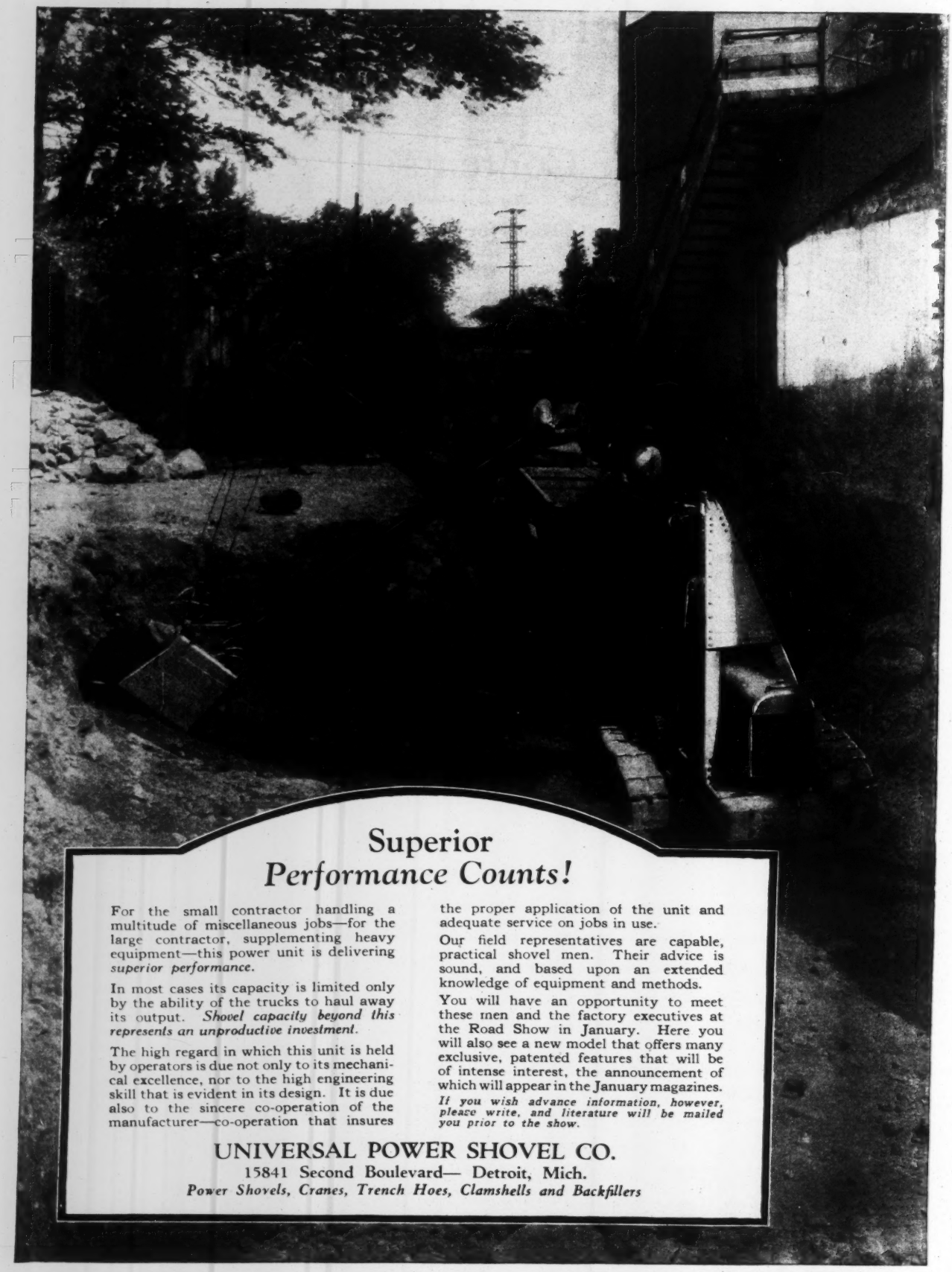

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Volume 101 NEW YORK, DECEMBER 13, 1928 Number 24

Changing Pump Types

AN INTERESTING picture of developments in pumping machinery is given in a diagram on p. 880 of this issue. Types of pumping equipment installed in the water-works of cities of more than 60,000 inhabitants in the United States since 1883 were classified and the four major types selected for making the diagram. Compound steam pumps were the order of the day when the period opened, but they soon gave place to the great triple-expansion pumping engines which held almost undisputed sway from the early nineties until after the opening of the twentieth century. In that period a few steam-turbine centrifugal pumps were installed; but it was not until after 1900 that any significant number was put into use. Triple-expansion pumps continued to be an important factor until 1915, but by 1910 both steam-driven centrifugal pumps and electric-driven centrifugals had come into wide use. Gradually the compound and triple-expansion pumping engines have become less and less a factor, until at the present day centrifugal pumps, either steam turbine or electric, are almost universally adopted in new installations. Of the two types, the diagram indicates that at least for cities of this size steam-turbine pumps are preferred.

Asphalt-Road Study

ASPHALTIC road interests have in a few years developed a powerful agency for good in their annual conferences on paving and roadbuilding practices. At New Orleans last week nearly half a thousand delegates considered a program of some 25 technical papers through five busy sessions. In the attendance highway engineers and contractors and the asphalt technologist were represented nearly as numerously as were the asphalt producing and marketing interests. The conference had specifically an engineering atmosphere and very little of the odor of promotion and merchandising. It has in full actuality become an engineering convention ranking in the quality of its papers and discussions with the conventions of any of the associations of roadbuilders—in brief, an educational agency in asphalt-road engineering. Such an agency has been greatly needed. Asphalt has suffered in popular estimation as a roadbuilding material because its extraordinary range of usefulness has not been comprehended, because it was easier to use poorly than to use well and because it has shown few construction improvements appealing to popular appreciation. The beginning of the use in the last two years of finishing machines is the first step in a generation to apply the accuracy of machinery to producing an asphalt riding surface. Even today the asphalt technologist has his mind more on some refinement in bituminous mastic design than he has on a road surface that can be built smooth and will stay where it is put. If the conference once a year of practical roadbuilders with the chemist and the salesman can bring a change in this attitude of mind it will justify its continuance. Perhaps, too, the leaven of the roadbuilder's viewpoint may arouse a consciousness of the fact that it is *asphalt* that has to be "sold" to the roadbuilder and the road user, not one brand or kind of asphalt; and that it has to be sold as a material of which roads can be easily and well built, not as a chemical formula.

Bids Asked at Last

AFTER a long controversy over material to be used and lesser features of design, and after many changes and counterchanges both in plan and engineers engaged, bids are at last being invited for the Wanaque aqueduct, a large construction job in northeastern New Jersey. In marked contrast to the first proposed change in plan, the contract specifications abstracted in this issue invite bids on seven types of aqueduct. Concrete for a portion of the aqueduct, as first proposed, was cut out midway in the period of controversy and is still out. The "smooth-bore" pipe to the exclusion of all other material, so much in evidence a year or more ago, has disappeared from the picture under that designation, and in its place there are specified, as possibilities, pipe fabricated in 30-ft. lengths from two single plates with lock-bar, hammer-welded pipe and riveted pipe with countersunk longitudinal joints. After a last-moment contest, pipes made from 7½-ft. plates, four to a 30-ft. shop length, are permitted, with differentials from the 74-in. base size for the three types just mentioned, running up to 78-in. for ordinary button-head riveted pipe. Except for the omission of autogenous welded joints, about every type of steel pipe in current use is permitted. The breadth of competition finally permitted has been wrenched from the commission only by a long and wearisome effort. In view of that history, the contracting communities and the engineers to the commission will do well to stand as firmly for impartial justice in the award of the contract.

Crossing Elimination Favored

AS BETWEEN grade-crossing elimination and automatic train control as safety measures, the Interstate Commerce Commission now favors crossing elimination. Consequently the commission will not, for the present at least, require railroad companies to add to the installations of automatic train control which are covered by existing orders. Thus have the railways won their point in an argument extending through several years in which they contended that money spent for automatic train control could be spent to greater advantage for other improvements. The victory has come, however, after several large railroad companies have become so convinced of the value of automatic train control as to have undertaken the installation of a considerable mileage voluntarily. It is quite possible that the commission took this development into consideration

in making its decision not to press for further installations. Officially it states that the greater number of crossing accidents has caused it to change its mind. When the casualties from crossing accidents are compared with those from train collisions, there is no doubt that the total for crossing accidents makes the more impressive figure; but whether it is any more impressive now, with the great yearly increase in automobile registration, than it was five or six years ago when the commission began to press for automatic train control installation is open to question. Yet there is a distinct gain in the change of attitude. Safety in railway traffic has gained appreciably through the impetus given to the use of automatic train control by the commission's mandatory requirements for extensive installation of such equipment. With that work well under way the commission now turns its attention to grade-crossing elimination to improve safety in highway traffic. Requirements for participation in this work by the railroad companies are notably lacking in uniformity in the several states in the Union, and many states have no definite schedule to which to work. A federal agency such as the Interstate Commerce Commission can do much to bring uniformity into this confused situation. Also, it may be expected to help in speeding up the work by acting as intermediary in any case where disagreement between the railroad company and the local community is holding up the work.

Making a Bad Matter Worse

IT IS common knowledge that both private and business life in cities have come to be very thoroughly entangled in the maze of street traffic. That is why traffic control today has sensational importance everywhere. But it is probably not so well recognized that the large and charitable mantle of traffic control covers many sins and errors —that in many cases a bad matter is made worse by faulty attempts to improve it. Hence the value of the Denver traffic article, in this issue.

Denver is by no means a shining example of bad practice. There are other cities like it, and it is cited merely as a convenient instance. But for that very reason—because it is representative—it merits more attentive study. It confronts us squarely with the question of why we should destroy and paralyze much of the difficult work of city building and city managing by inept practices in traffic handling.

When the engineer lays out an 80-foot roadway, adequate for six lanes of traffic, and finds that it is limited to single-file (two-lane) driving, he is bound to lose patience with those in charge of operation. He becomes still further exasperated when he finds that he is expected to remedy this faulty condition by more construction and expenditure. He cannot but reflect that a city with unusually large street area (40 per cent of the total area) and with low building height should find it quite possible, and indeed reasonably easy, to insure free flow of traffic. When he sees wide safety zones with driving to their left prohibited; parking spaces clogged because of poor enforcement of the regulations; a multiplicity of nonprogressive signal lights queerly arranged, and other hurdles to traffic, he must doubt whether street operation is yet beyond the stage of tottering infancy.

Lack of engineering direction, not to say of any intelligent management of traffic, is a pointed defect of Denver's condition. There are, even, few statistics on which traffic operation might be planned. Cities which have set up a traffic engineer, as Detroit and San Francisco find quick advantage in quantitative appraisal of the traffic problem. Only recently we reported in some detail how San Francisco is profiting by engineering control and day-by-day study of operating conditions.

Traffic management has in these days come to be an engineering problem. Its complexities and its urgent demands are such that the attempt to operate the complex and busy mechanism of street traffic without engineering study leads to evil instead of good.

The Boulder Dam Report

PUBLIC service of unusually high type is reflected in the report of the Engineering Board of Review on the Boulder dam project. Responding fully, sanely and unequivocally to the queries placed before it, the report answers the major doubts with which Congress and the general citizen were disturbed last spring in the discussion of this contentious issue. It illuminates many points in which the main issue has been obscured. It accomplishes these things by means of broad and wise treatment of the subject—and herein the report is distinguished. All too often the work of a board or a committee exhibits less wisdom than is possessed by its individual members; in the present instance the excellence of the results embodies the conjoined wisdom of the group.

What does the board set forth? It gives full answer to four major questions.

First, it declares that the proposed 550-foot dam is feasible, is capable of being safely and readily built. Last spring, it will be recalled, suspicion was cast upon the feasibility of this great structure; at a time when bitter opposition was being centered upon the project on the score of power and of Arizona royalty claims, the failure of the St. Francis dam served as basis for intimations that the proposed dam would not be safe, since, apparently, no dams were safe. The report states positively that it is safe, whether placed in Boulder Canyon or in Black Canyon. The board takes an extreme attitude of conservatism in its comment on the design, and this cannot reasonably be criticised, for in a work of such character and magnitude it is indeed wise to purchase extra insurance. But in fairness one should note that the prior design is not condemned as either unsafe or radical.

Second, it finds that the project will be effective to carry out the specific combination of purposes for which it was devised—namely, flood control, silt removal, flow equalization for most efficient water supply, and power generation. Here also important doubts were at issue, having been raised by many claims, based on small-scale facts and interpretations, that the combination of hydraulic functions is not practicable. Therefore, the clear-cut judgment expressed by the board is highly valuable. Here again a most conservative attitude is taken. The board rates the total flow lower, and the possible flood flow higher, than heretofore estimated—a sound procedure in a review by an appellate tribunal of a stream having such limited records and such picturesquely varied phenomena as the Colorado. The board's figures may not be nearer right than those previously calculated, but they are on the safe side.

Third, it concludes that the canal into the Imperial Valley can be built and maintained successfully, contrary to what had been claimed by many critics.

Fourth, it holds that the power byproduct of the dam is needed and is valuable, and that the project will pay, after

due deduction (which, as we understand the past proceedings, has previously been contemplated) of flood-protection charges and the cost of the Imperial Valley canal. Significant and unreserved is the board's statement that the near-by territory has a power demand large enough to absorb the output of the project. This verdict sweeps away most of the background of the antagonism displayed by some of the utility interests—though the most farseeing have long appraised the situation in a more progressive light.

Several auxiliary questions are also disposed of by the report, but these four are of outstanding moment. They are sufficient to strip the project of much of the doubt in which it has been veiled and to place the central issue fully and fairly before Congress.

The board confined itself to the questions which it was instructed to answer, and therefore it did not touch many of the sore points of the Boulder dam case. But it is for Congress to decide whether this great, costly and far-reaching enterprise of controlling a menacingly wild river for the protection and development of the Southwest is a proper and a desirable national function; to decide, among other things, whether the Colorado River compact is a secure basis for the utilization of the water; to determine how the inevitable involvement of power production in the project shall be dealt with; whether the Imperial Valley canal is a constructive method of improving the dangerous status of water supply at the Mexican border; whether it is best to allot the stored water by states or to leave it subject to the established doctrine of beneficial appropriation under the remarkable circumstances surrounding the use of the lower Colorado; and whether the insistent claims of Arizona for power royalties ought to be recognized.

These and related questions were not before the board, and they would have been dangerous obstacles to a clear and firm disposal of the question specifically placed before it. That the board kept its studies and judgment free of these complications is a matter for sincere congratulation.

Lessons in Great Projects

GREAT engineering structures that define new limits of accomplishment are of infrequent occurrence and few engineers of the many that comprise the profession ever will be associated with one of them. For this reason there is often a lack of active interest on the part of some engineers toward works of great magnitude. It is true that they may marvel at their size and perhaps may realize their advertising value to the profession, but too seldom do they recognize an intimate relation between these great monuments and their own smaller jobs. Yet the same set of economic forces brings into being both the great and the small structures.

Looking back over the last half-century's construction achievements to consider the projects which have stood as symbols of engineering attainment and have fired the public imagination—such works as the Brooklyn suspension bridge, for example, or the Singer and Woolworth buildings, the Pennsylvania tunnels under the Hudson River, the Panama Canal, the Niagara and the Hell Gate arch bridges, the Chicago drainage canal, the Roosevelt and Arrowrock dams, the great hydro-electric developments of the Far West and the under-water vehicular tunnels in New York City and Oakland—who can say that these projects have not had an effect upon the most humble of engineers? And who can say that a wider knowledge of the problems solved in their construction would not have made the subsequent pathway of all engineering development easier?

History is repeating itself today, and we have under construction in the metropolitan area of New York City two great bridges far in advance of the past and greater than all but a chosen few of the present engineering generation will have opportunity to attempt. Yet careful study of them will pay every engineer in dividends of detailed technical knowledge, broader vision and greater appreciation of modern methods and materials.

The Hudson River bridge in one sweep increases the span limits of existing suspension structures from 1,750 to 3,500 feet. With its 36-inch cables containing a greater cross-section of wire than all the long-span suspension bridges in this country combined, and its structural towers rising to the height of a 45-story building, it suggests little of the average structure. Yet in its design and construction are contained engineering principles and practices of wide application. Methods for constructing open cofferdams have been extended to new depths and conditions. Immense yardages of concrete have been poured without interruption. Rock-drilling operations have been completed that compare in difficulty and yardage with rock cuts and tunneling work anywhere. Metallurgical and strength tests of cable wire present examples of industrial research that can profitably be emulated on smaller projects. Stress analysis of the towers, both analytically and by model, offers new encouragement for the assured safety of indeterminate structures. It is certain that as the bridge proceeds toward completion it will offer many other practices of wide applicability.

The Kill van Kull steel-arch bridge, with its span of 1,675 feet, nearly twice that of prior arches, is equally far beyond present standards. Yet, as may be seen from the article describing it elsewhere in this issue, its problems will not be entirely foreign to civil engineering construction generally. For instance, the thoroughness with which comparative designs were made for both suspension and arch types is an excellent example of the application of technical and business sense to engineering. The extensive use of alloy steels is a demonstration of the value of high-priced materials under certain conditions. The use of heavy steel forgings in the hinges calls attention to the fact that radical departures from conventional methods await only the designer's ingenuity to prove themselves economical. Lessons from its erection procedure are not yet determined, but the fact that the erectors must maintain an open ship channel beneath the bridge almost 700 feet wide will require ingenuity and courage of a high order.

Each of these structures was made necessary by the economic trends of the times, which affect small and large structures alike. Both are being built to meet the requirements of the modern motor vehicle and thus forcibly impress the fact that the highway has replaced the railroad as the prime field of the bridge builder. Another factor of importance is the enlightened business sense that permitted the structures to be built as public toll-refunding projects whose potential earning powers were determined to be ample to assure their ultimate operation as free bridges.

Increased knowledge of these economic trends and a better appreciation of the lessons inherent in our great engineering structures should benefit the entire profession. No engineer worthy of the name can afford to regard them as projects that are out of his field.

Sinking Open Concrete Caissons for Foundations

Tall Chimney at Cement Plant on Large Filled Cylindrical Caisson—Raw Material Storage Bins on 64 Smaller Caissons Filled to Form Piers—Plant and Methods

By S. W. Bowen
Vice-President Fruin-Colnon Contracting Company, St. Louis, Mo.

DIFFICULT foundation work, with special methods of construction for piers to carry heavy concrete structures, was a feature in the building of a new cement-manufacturing plant for the Missouri Portland Cement Company at Prospect Hill, Mo., a town adjacent to the north side of St. Louis and on the bank of the Mississippi River. The storage bins for cement, clinker and broken stone, as well as a 223-ft. chimney, are supported on piers formed by reinforced-concrete cylindrical caissons sunk to a stratum of fireclay or hardpan at an average depth of about 62 ft. A view of the construction work in progress is shown in Fig. 1.

Soil conditions at the site are very unfavorable. For a depth of about 60 ft. there is clay of various kinds, interspersed with layers of fine sand. Veins of groundwater, which are struck at different elevations, saturate the soil and cause dangerous slides whenever an excavation is opened to any considerable depth. Solid material consisting of fireclay, shale and hardpan is found approximately 60 ft. below the average ground surface. In some cases limestone, consisting of layers from a few inches up to about 2 ft. in thickness, is encountered at about the same depth. As the engineers did not consider this to have much more bearing value than the shale, all foundation piers were made of such diameter as to give the bearing required for shale.

A number of borings were made, test piles were driven and finally test caissons were put down to determine the actual soil conditions. Typical borings are shown in Fig. 2. A test pile driven to a bearing on the fireclay showed no settlement under a load of 100,900 lb. and a maximum settlement of $\frac{3}{16}$ in. under a load of 120,600 lb. sustained for several days. A similar pile gave the same maximum settlement under a load of 150,500 lb. sustained for five days.

After considerable study of the soil conditions, it was decided to sink reinforced-concrete caissons to support the bins or silos and also the chimney, and to extend these to rock or fireclay as might be found most feasible. The caissons were then to be filled solid with concrete.

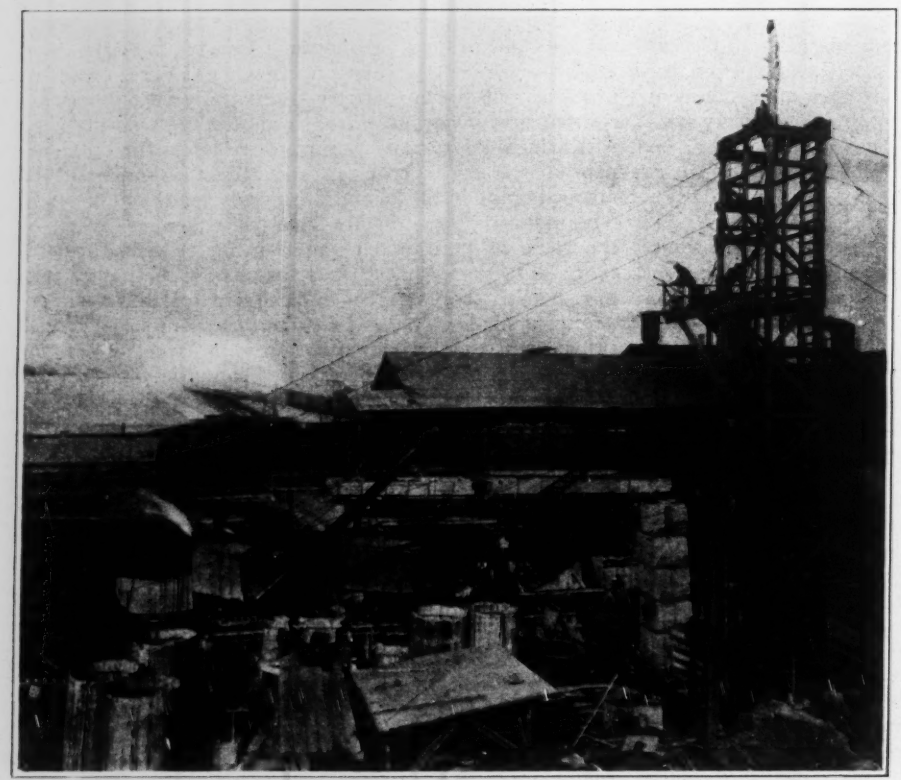


FIG. 1—FOUNDATION WORK FOR CEMENT PLANT
Concrete caissons being sunk to support storage bins. At left of concreting tower is a caisson loaded with 2-ton concrete blocks. Cranes handle grab buckets for excavating inside caissons.

Chimney Foundation—The caisson for the chimney foundation was the first one to be sunk. This chimney is of reinforced concrete and is 19 ft. 5 in. in diameter at the bottom, has a total height of 223 ft. above the base, and weighs about 1,037 tons exclusive of the base. For this foundation a reinforced-concrete cylindrical caisson was constructed, having an outside diameter only slightly larger than that of the chimney and having a tapered cutting edge. This caisson (Fig. 3) was built on blocking, using inside and outside wood forms in sections 10 ft. high.

The first 10 ft. section was 19 ft. 8 in. in diameter, with wall 42 in. thick above the cutting edge. The concrete for this bottom section was made with an early-strength cement. After this section had hardened sufficiently, the forms were removed and excavation was started within the caisson by means of a clamshell bucket handled by a crane on crawlers. Cranes of this type were

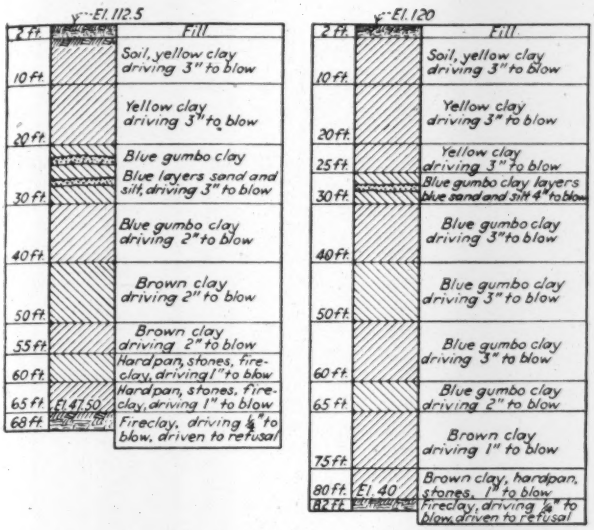

El. 112.5
2 ft.
Fill
10 ft.
Soil, yellow clay driving 3" to blow
20 ft.
Yellow clay driving 3" to blow
Blue gumbo clay
30 ft.
Blue layers sand and silt, driving 3" to blow
40 ft.
Blue gumbo clay driving 2" to blow
50 ft.
Brown clay driving 2" to blow
55 ft.
Brown clay driving 2" to blow
60 ft.
Hardpan, stones, fireclay, driving 1" to blow
65 ft.
El. 47.50
Hardpan, stones, fireclay, driving 1" to blow
68 ft.
Fireclay, driving ¼" to blow, driven to refusal
El. 120
2 ft.
Fill
10 ft.
Soil, yellow clay driving 3" to blow
20 ft.
Yellow clay driving 3" to blow
25 ft.
Yellow clay driving 3" to blow
30 ft.
Blue gumbo clay layers blue sand and silt 4" to blow
40 ft.
Blue gumbo clay driving 3" to blow
50 ft.
Blue gumbo clay driving 3" to blow
60 ft.
Blue gumbo clay driving 3" to blow
65 ft.
Blue gumbo clay driving 2" to blow
75 ft.
Brown clay driving 1" to blow
80 ft.
El. 40
Brown clay, hardpan, stones, 1" to blow
82 ft.
Fireclay, driving ¼" to blow, driven to refusal

FIG. 2—TYPICAL BORINGS FOR FOUNDATIONS
Notes "3 in. to blow," etc., indicate penetration to test piles.

used on all parts of the work. At the same time the earth around the inside of the cutting edges was removed by hand sufficiently to allow the 10-ft. section to settle into the ground. Meanwhile a second 10-ft. section was started on top of the first, this being 19 ft. 6 in. in diameter, with wall 36 in. thick. The increased loading produced additional settlement, and this process of excavating and concreting was continued until the caisson shell had reached the fireclay stratum on which it was to rest.

Whenever groundwater or water-bearing sand was encountered during the sinking, the hand work was discontinued and the earth inside the caisson was excavated by the clamshell bucket below the cutting edge to such an extent as to allow the caisson to settle through the stratum of soft material, thereby cutting off most of the water. When the caisson reached the compact fireclay stratum, it was held by blocking at the bottom to prevent further settling while the clay was excavated and belled out for a footing block 8 ft. 8 in. thick and having a base 26 ft. in diameter, in order to give a greater bearing area, as shown in Fig. 3.

The bearing weight allowed on the fireclay for this chimney foundation was 10 tons per square foot, taking into account wind pressure as well as the direct load of chimney and pier. The weight of caisson, footing and top slab was about 818 tons. While the design included filling the caisson with a lean 1:6:12 concrete if necessary, this filling was not placed, since the weight of the caisson was found ample to provide the required stability.

Concreting Methods—Concrete for the caisson was a 1:2:4 mix, deposited by chuting from a mixer located on the edge of the general excavation. This plan was made possible by the fact that the first section of the caisson was started in a pit, so that the top of the section being concreted was always below the level of the mixer. The same plan was applied also to the smaller caissons under the storage bins. There was a twofold reason for this pit arrangement. In the first place, it gave a rigid bank against which to brace the caissons, thus holding them plumb and preventing them from getting started in any but a vertical direction. In the second place, it provided to some extent for the excavation required for the reinforced-concrete caps which were placed on top of the caissons under the bins, as described later.

When the large caisson was completed, it was covered with a 2-ft. slab of reinforced concrete, forming the base of the chimney. It will be noted that the wall thickness of the caisson was increased for 8 ft. at the top by widening gradually from the inside. Projecting from the top of the caisson wall was a ring of 108 anchor bars for the chimney wall or shell. These are 1 in. square and 15 ft. long. They are continued down to the base of the caisson by ¾- and ½-in. round bars in lengths of 12 and 13 ft., the lengths being wired together. These bars are independent of the vertical reinforcing bars.

Bin Foundation Piers—For the cylindrical storage bins or silos, the foundations consist of four reinforced-concrete caissons under each silo, making a total of 64 caissons or piers. There are 32 under the cement bins, sixteen under the stone bins and sixteen under the clinker bins. They have a diameter of 8 ft. on the outside and 6 ft. 4 in. on the inside. The general arrangement is shown in Fig. 4.

These caissons vary in depth, depending on the elevation of the fireclay stratum, but average approximately 60 ft. from the top of caisson to the bottom of the bell resting on fireclay. The maximum bearing pressure of each caisson footing block on the fireclay stratum was taken at 10 tons per square foot, with a possibility of increasing this to 20 tons if rock was encountered. Only three caissons, however, are on rock, and in all cases the size of the bell was made such that the maximum pressure on the foundation stratum did not exceed 10 tons per square foot. This was done on account of the poor quality of the rock, as already noted.

The same method of sinking was used for these 8-ft. caissons as in the case of the larger caisson for the chim-

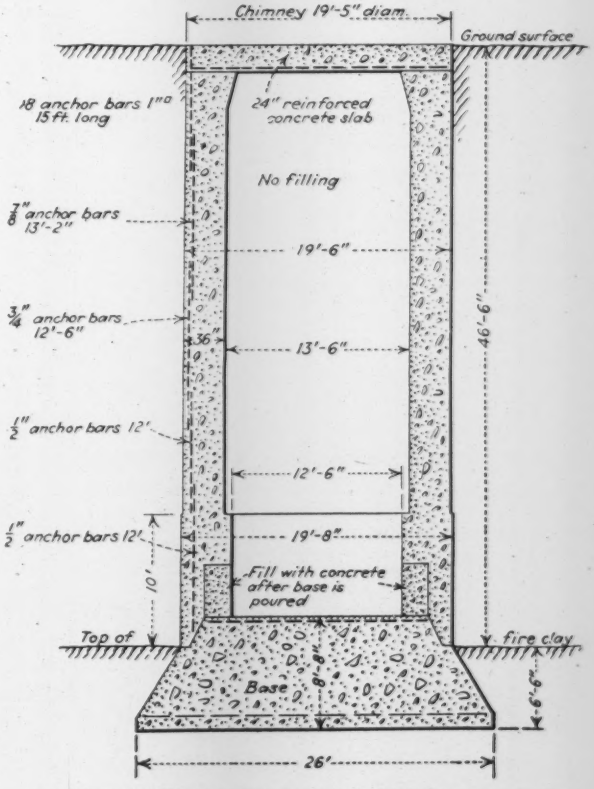


FIG. 3—LARGE CAISSON FOR CONCRETE CHIMNEY

ney. Some difficulty was encountered in two or three cases where the caissons stuck and had to be shot in order to loosen them. When for any reason a caisson refused to move after being loaded as heavily as was practicable, three or four pipes about 1½ in. in diameter were driven on the outside, close to the caisson wall. These pipes were plugged at the bottom and each contained a light charge of dynamite, usually half a stick. The pipes were driven until their ends were at about the level of the cutting edge of the caisson, and the charges were fired simultaneously by a battery. The effect of the blast was to break the friction sufficiently to cause the caisson to drop a foot or more, after hanging for a fraction of a second.

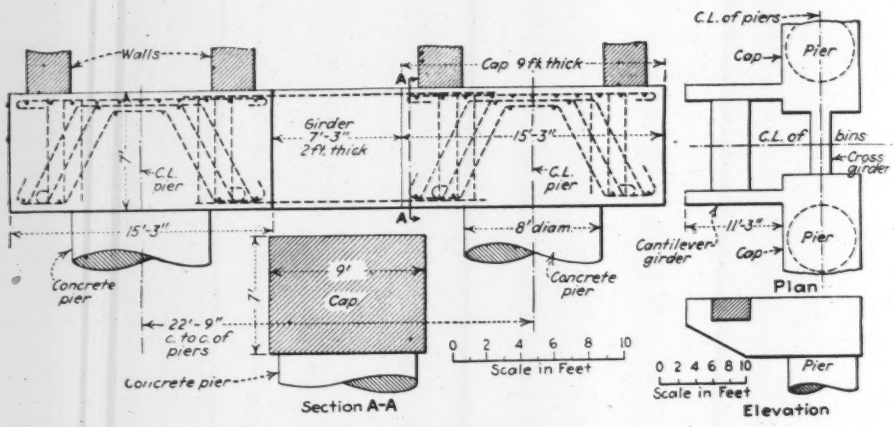


FIG. 5—DETAIL OF BIN FOUNDATIONS
At left, piers and caps. At right, cantilever girders on end piers.

The weight of these smaller caissons above the ground was not sufficient to sink them, so that they were loaded with concrete blocks weighing about 2 tons each. The blocks had loops made of reinforcing bars, so that they could be handled by the crawler cranes. As many as twenty of these blocks were placed on a single caisson. This loading is shown in Fig. 1. In general, however, no unusual difficulties were encountered in the sinking. Shooting was resorted to only in extreme cases.

Unwatering and Filling Caissons—When the fireclay stratum was reached, the caissons were belled out to give the proper bearing and the stratum was tested by drilling to a depth of about 8 ft. After this the hole was cleaned out and filled with concrete, the entire interior of the caisson being filled to the top. This filling was chuted from the mixer in the same way as the concrete for the caisson shells. At the cement storage silos, where a double row of bins occurred, a short tower was employed of sufficient height to enable the chute to reach the farther caissons. In a few cases some difficulty was experienced from water, but this did not prove serious after the fireclay stratum was reached. During sinking, the water was handled by gasoline or electric pumps. In some caissons which had been allowed to settle without hand excavation there was a considerable accumulation of water, and this was bailed out with a bucket handled by a crawler crane.

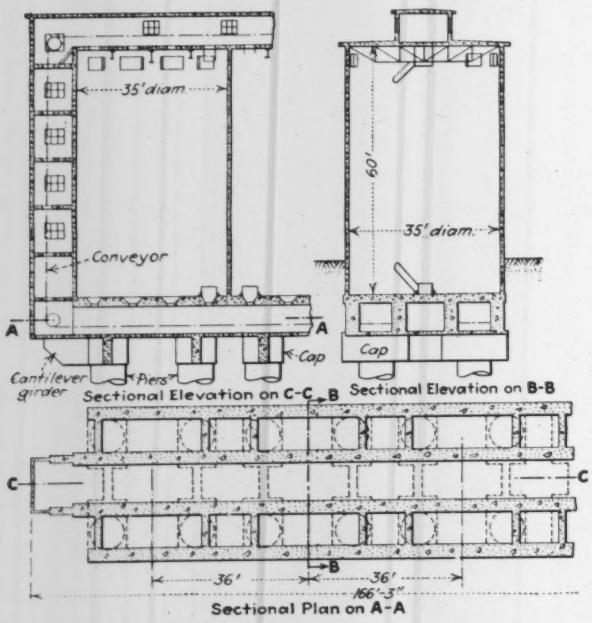


FIG. 4—STORAGE BINS AND FOUNDATIONS

Concrete Girders and Piles—The load from the silos is distributed to the piers thus formed by means of reinforced-concrete girders under the floor slabs. These girders, which also form the walls of the tunnels for the unloading conveyors, rest on heavy reinforced-concrete caps forming the tops of the caissons, as shown in Figs. 4 and 5.

In addition to the caissons, there was a large number of precast reinforced-concrete piles, ranging from 30 to 60 ft. in length and aggregating 35,000 lin.ft. These were used under the slurry basins, kiln piers and various other points where the loading was too light to require piers and where piles could be used to advantage. Under the corners of the kiln piers 60-ft. concrete batter piles were driven to aid in resisting the vibration due to the rotation of the kilns.

Designers and Builders—This cement plant, including equipment, was designed by F. L. Smith & Company, engineers, New York, under the direction of O. E. Mogensen, secretary of that company. The entire foundation work and also the superstructure work, with the exception of the circular bins and the chimney, was built by the Fruin-Colnon Contracting Company. The silos, above the foundation caps, were built by the Gamble Construction Company, and the concrete chimney was built by the Boland Construction Company, all of St. Louis. All construction work was under the direction of D. N. Armstrong, vice-president and general manager, and George Ross, assistant general manager, of the Missouri Portland Cement Company, St. Louis, Mo.

Road Congress to Be Held in U. S.

European roadbuilders have accepted the invitation of Congress to hold an International Road Congress in the United States in 1930, according to Thomas H. MacDonald, chief of the United States Bureau of Public Roads, who returned recently from a meeting of the International Road Commission at Paris.

Design of the 1,675-Ft. Kill van Kull Steel-Arch Bridge

Port of New York Authority's Fourth Toll Bridge Project Connecting New Jersey and New York City—Two-thirds Longer Span Than Famous Hell Gate Arch—Four-Lane Capacity in Initial Construction, but Designed for Six Highway Lanes or Two Rapid-Transit Tracks With Four Highway Lanes—Over Half of Tonnage Is Alloy Steel

ACTIVE CONSTRUCTION has been begun on the longest steel-arch bridge in the world. This new highway structure over the Kill van Kull in New York City's metropolitan area will have a span of 1,675 ft. center to center of bearings, which will be 25 ft. longer than the great Sydney harbor arch now being erected in Australia and 680 ft. longer than the famous Hell Gate bridge over the East River.

At present the steel sheetpiling cofferdams are in place and the contractor's plant is being assembled for pouring frames cast in the skewbacks, its use of heavy steel forgings for hinge bearings, its unusually long floor-beams and its utilization of alloy steels in an amount exceeding 50 per cent of the total steel in the arch (the latter incidentally making it possible to carry the tremendous thrust of about 28,000,000 lb. on a gross arch-rib area of less than 1,000 sq.in.), the structure contains technical detail of outstanding merit. It is largely with these structural features and the studies leading up to their design that this article will deal.

From a drawing by John T. Cronin

FIG. 1—THE KILL VAN KULL HIGHWAY BRIDGE, A 1,675-FT. STEEL ARCH BETWEEN NEW JERSEY AND STATEN ISLAND, NEW YORK CITY

the arch abutments. Bids for the steel superstructure were opened on Nov. 19 and the contract was awarded Nov. 25 to the American Bridge Company for $5,019,000, which includes both approaches. The contract requires that the steelwork be in place ready for concrete roadway construction by April 1, 1931.

The Kill van Kull bridge, as the other bridges recently completed and being built over the waters between the states of New York and New Jersey, is unusual in its economic aspect. Traffic relief, improved communication and trade expansion are promised for the sections which it joins. Besides, it will provide the closing link in a highway between Manhattan and Staten Island, respectively the most populous and the least developed of the boroughs of New York City. The map, Fig. 2, shows the location of the bridge and its relation to the other crossings between New York and New Jersey; the new highways to be built connecting these crossings are also shown.

As an engineering achievement in two-hinged steel arch building, the Kill van Kull bridge is first notable for its great length, attaining at the same time a grace of outline hardly possible with any other type of structure. And in its comparatively simple foundations, its ingenious method of setting the arch shoes on steel

Comparison With Hell Gate Bridge—Any consideration of the new Kill van Kull steel arch challenges comparison with the famous Hell Gate arch structure, which at the time it was completed in 1916 was the longest bridge of its type in the world. The first and fundamental difference between the two structures rests in the type of load. The Hell Gate bridge was designed for one of the heaviest live-loads that any bridge has ever been called upon to carry (Cooper's E-60 on four parallel tracks), while the Kill van Kull bridge loads will consist of conventional highway vehicles and the possible addition of two rapid-transit lines. As a result, and in spite of the great difference in length of span (1,675 ft. and 995 ft. 1⅞ in. c. to c. of bearings), the maximum arch reactions of both bridges are practically equal. Although the principal members of the Hell Gate arch are actually heavier than those in the Kill van Kull arch, the appearance of lightness in the latter structure is accentuated by the great length of span.

In more detail the respective values of dimensions, weights and loads for the Kill van Kull and Hell Gate arches are as follows: Height of center of top chords above mean high water, 327 ft. and 305 ft.; width center to center of arch trusses, 74 ft. and 60 ft., although on the Hell Gate arch the wind trusses are placed outside

of the main arch trusses and have a width of 95 ft. c. to c.; outside dimensions of maximum sections, 5 ft. 5 in. x 6 ft. 10 in. and 6 ft. 6 in. x 10 ft. 8 in.; maximum gross area of arch rib, 983.5 sq.in. and 1,384 sq.in.; total reaction on skewbacks, 29,400,000 lb. and 30,544,000 lb.; total weight of steelwork, 34,324,000 lb. and 37,770,000 lb.; dead-load per foot of bridge, 27,000 lb. and 51,000 lb.; live-load per foot of bridge, 5,600 lb. and 24,000 lb.; and thickest plate used, 1½ in. and 2 in.

An innovation on the Hell Gate arch was the use of special high-carbon steel, permitting higher working stresses. Although alloy steels were considered, the differential between carbon and nickel steel at that time was $40 per ton in favor of the former. Both nickel and silicon steels are used extensively in the Kill van Kull arch, and the price differential is such that a considerable total saving was effected over the use of carbon steel.

History of the Project—Ferries have operated on the Kill van Kull for more than 100 years. The first highway crossing was proposed in 1909 to connect Bayonne, N. J., with Port Richmond, Staten Island, but not until the Holland tunnel was assured were the real possibilities of such a crossing realized. In 1925 and 1926 the states of New York and New Jersey, by legislative act, gave the Port of New York Authority permission to construct, operate and maintain a bridge at this point over the Kill van Kull, and each state appropriated $50,000 for preliminary studies and surveys. Congress had authorized the bridge previously.

In the early spring of 1927 further legislation was enacted making available for the bridge $2,000,000 from each state. The remainder of the total cost of $16,000,000 necessary for initial completion of the bridge was provided by $12,000,000 of Port Authority bonds issued in January, 1928. Both the bonds and the advances from the states will be paid from toll collections on the bridge.

Preliminary studies had indicated that the potential traffic for a bridge connecting the Bayonne peninsula to Port Richmond, Staten Island, would support the structure even during its first year of operation and had favored a steel arch structure with a span of 1,000 to 1,700 ft. and a maximum navigation clearance height of 150 ft. After funds for the bridge were assured these studies were checked and in some cases revised. The estimated annual volume of traffic in 1932 was determined to be 950,000 vehicles with an increase to 2,000,000 five years later and to 4,000,000 in 1950. With a charge of 60c. for all vehicles except trucks and buses, of 5c. for passengers in all vehicles, of 75c. for trucks and buses

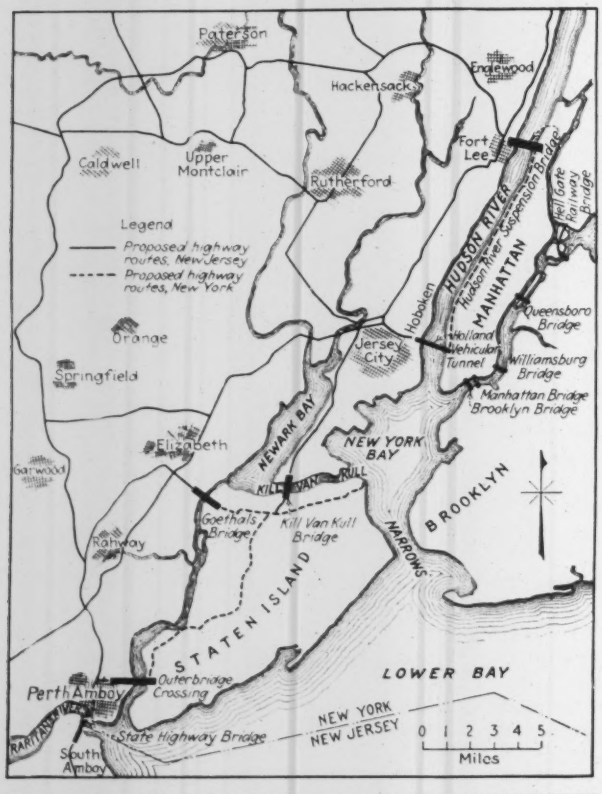


FIG. 2—KILL VAN KULL BRIDGE AND ITS RELATION TO THE OTHER NEW YORK-NEW JERSEY HIGHWAY CONNECTIONS

COMPARATIVE ESTIMATES OF COST—ARCH AND SUSPENSION DESIGNS

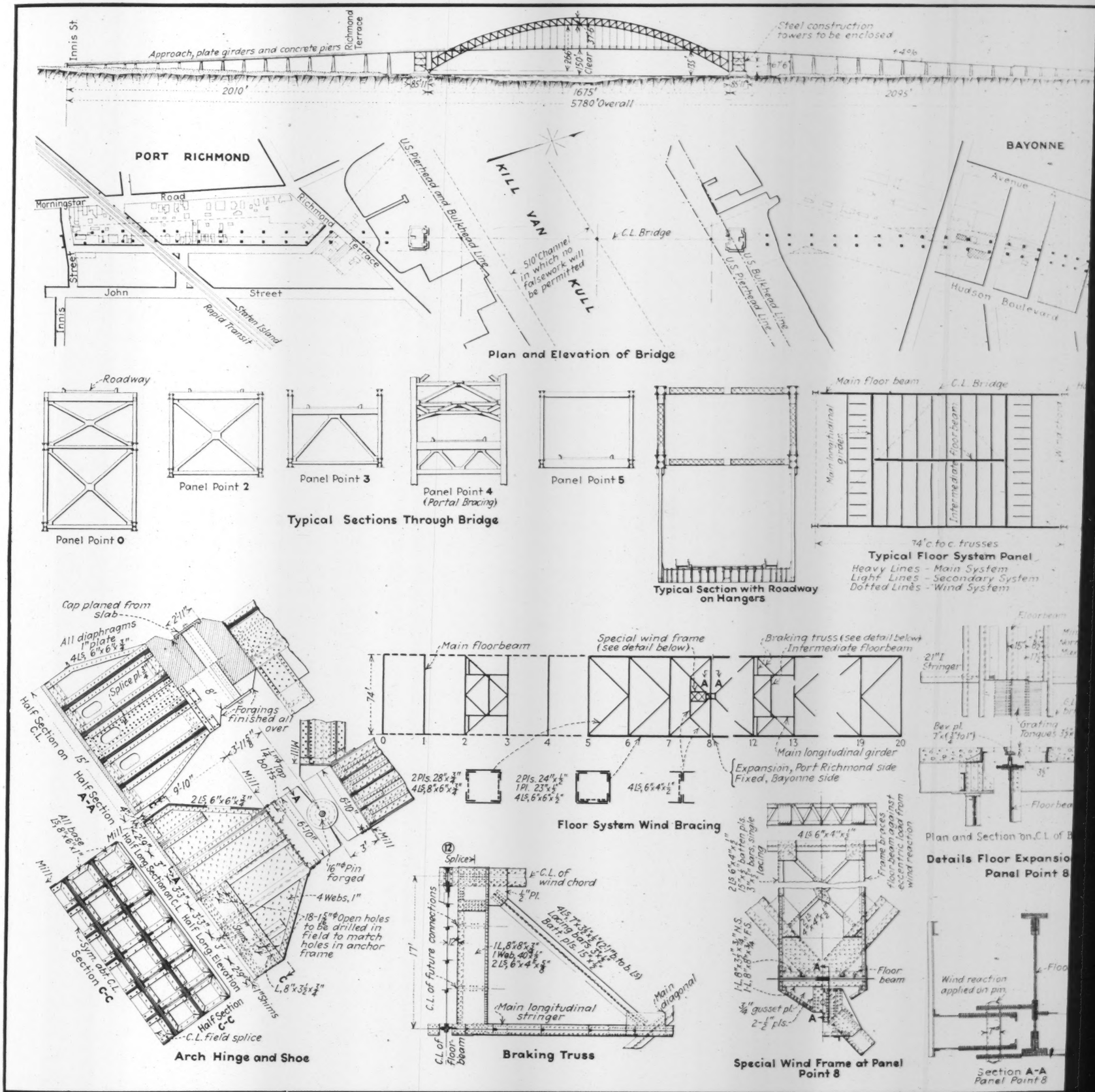
	Arch Design	Suspension Bridge
Main bridge construction	$6,640,000	$7,990,000
Approaches and plazas construction	4,010,000	3,660,000
Total initial construction	$10,650,000	$11,650,000
Engineering	640,000	700,000
Real estate	2,400,000	2,550,000
Administration	200,000	200,000
Contingencies	770,000	850,000
Interest	1,340,000	1,450,000
Total initial cost	$16,000,000	$17,400,000
Additional cost	2,000,000	2,200,000
Total final cost	$18,000,000	$19,600,000

and an annual maintenance and operation charge of $150,000 to $250,000, a gross income of $780,000 was predicted for the first year of operation, increasing to $1,500,000 five years later and to $3,250,000 in 1950. These figures represented respectively 5.23, 10.95 and 24.87 per cent net operating income on a capitalization cost of $12,000,000.

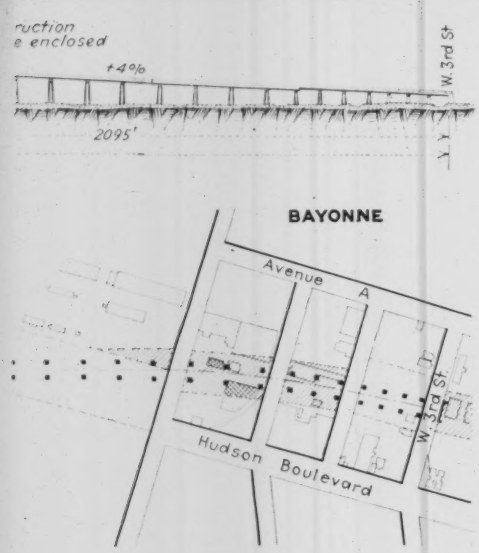
After considering a number of roadway arrangements, the design was made to provide for six highway lanes and was also made strong enough to carry four such lanes and two rapid transit tracks; initial construction would include only the four center highway lanes. The question of including facilities for rail freight was considered, but this feature was dropped in the final plans. The site chosen placed the bridge at a considerable skew, requiring a somewhat longer span than other available sites, but any disadvantage from this was believed to be offset by much more economical approaches, principally occasioned by cheaper right-of-way.

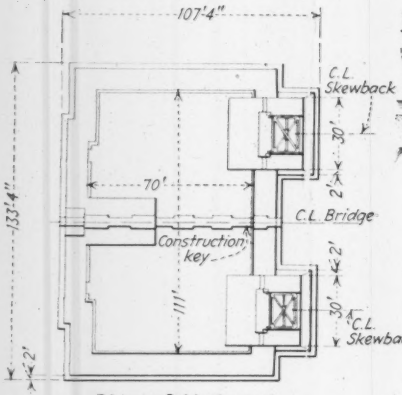
Considerations of type of structure involved the arch, suspension and cantilever, although the latter was early dismissed from study because it was easily the most expensive and was believed to be esthetically inferior to either of the two others. Complete and careful examinations, however, were made of designs for the two other types. Recognizing ample rigidity as of major importance should rapid-transit trains be placed on the structure, the arch was shown to have an advantage, since the calculated deflections of the comparable suspension span were 7½ times those of the arch. A smaller cost of painting for the suspension bridge was possible, but the saving was not large. The consensus was that the relative appearance of the two designs favored the arch.

Estimates of cost showed the arch to be the cheaper structure by $1,000,000 to $1,500,000, as shown in the accompanying table. While the low, flat banks on both sides of the river, with rock outcropping near the surface, are ideal for arch abutments, they would make

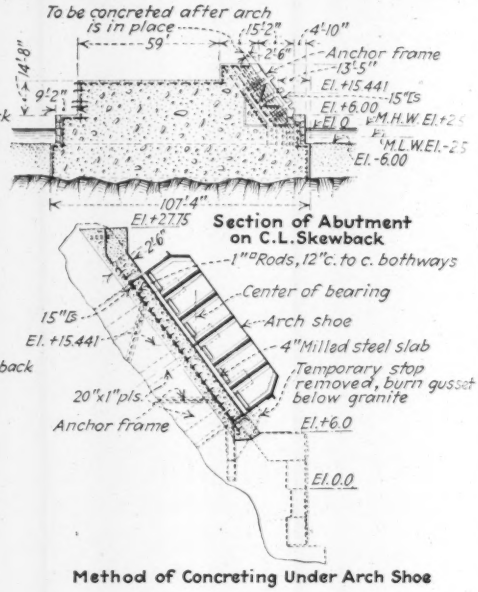


Principal Structural Features of 1,675 ft. Steel-Arch Highway Bridge Between Bayonne, N. J., and

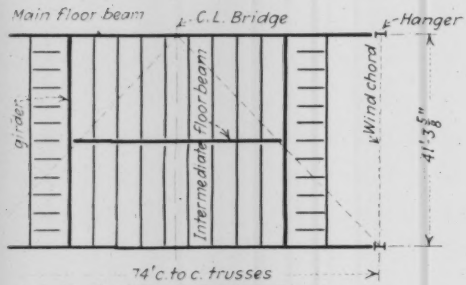




Plan of Abutment

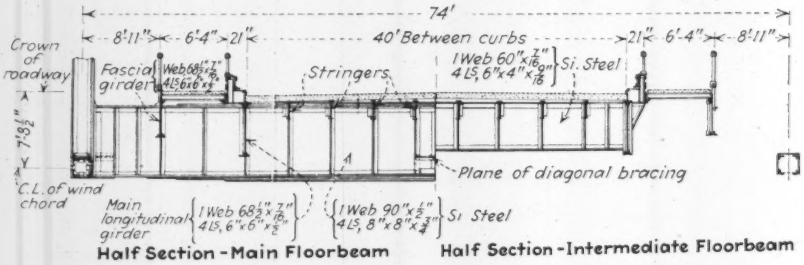


Method of Concreting Under Arch Shoe



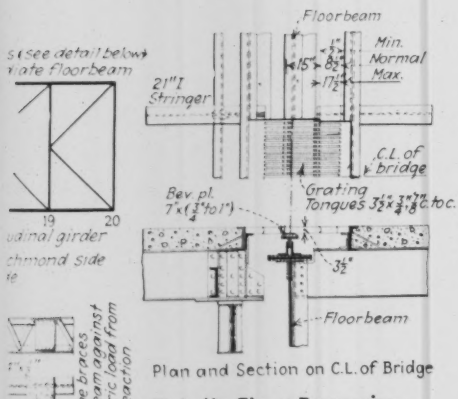
Typical Floor System Panel

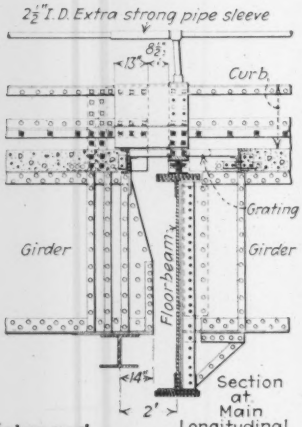
Heavy Lines - Main System
Light Lines - Secondary System
Dotted Lines - Wind System



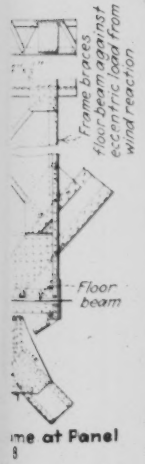
Half Section - Main Floorbeam

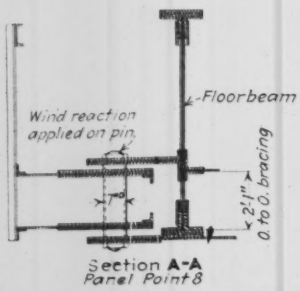
Half Section - Intermediate Floorbeam



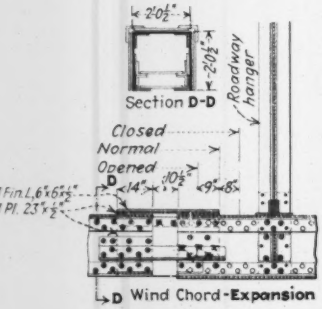


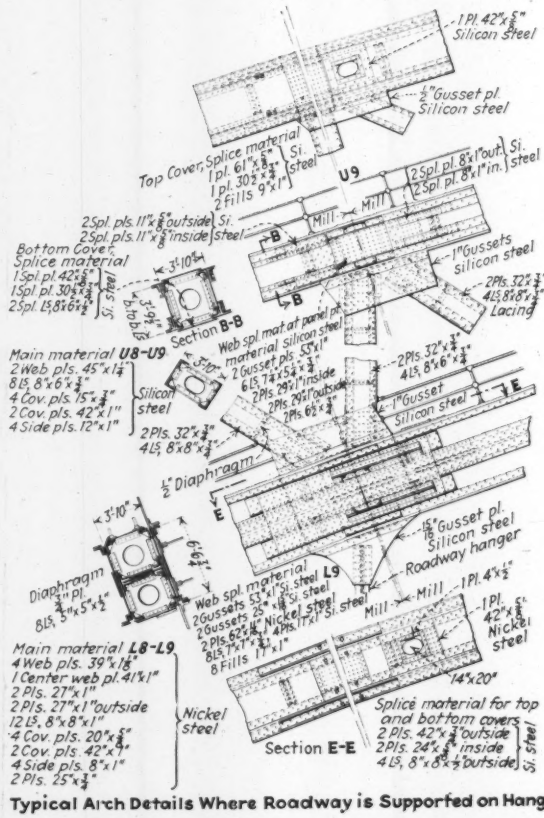
Details Floor Expansion, Panel Point 8, Port Richmond





Section A-A Panel Point 8





Typical Arch Details Where Roadway is Supported on Hanger

Between Bayonne, N. J., and Port Richmond, Staten Island, New York City

necessary high and expensive anchorages for a suspension span. The suspension design, in order to be comparable with the arch, placed the stiffening trusses practically below the floor in order to permit an unobstructed view sideways. This requirement necessitated a higher elevation of the floor for the suspension design and involved steep objectionable approach grades. Competitive bids on the two types would not, in the opinion of the engineers, secure as advantageous a price as a bid on a single type. Also, if one type were immediately selected, designs could be completed ready for bid advertisements a year earlier than if two separate designs were necessary, and thus a considerable sum in interest would be saved. In view of these considerations, the steel arch design was adopted for its "superior economy, ample rigidity, and good appearance."

General Arrangement—The Kill van Kull bridge is a parabolic steel arch 1,675 ft. center to center of arch bearings and 1,652 ft. center to center of pins. It crosses the Kill van Kull on a considerable skew in an approximate north-south direction. The arch has a rise of 274 ft. from the center line of bearings to the center line of the lower chord, and the depth between the chords of the arch trusses is 37½ ft. at the center, with a slight flare toward the ends. A clearance of 150 ft. above mean high water is provided at the center of the arch span, while at any point in a channel 1,000 ft. wide the clearance is 135 ft. The approaches are each about 2,000 ft. long and consist of plate girders resting on concrete piers.

The panel-point curves of both the upper and the lower chords are true parabolas. The two arch trusses are 74 ft. center to center, providing a clear roadway width of 65 ft. Provision is made in the design for 7½-ft. sidewalk brackets outside of each arch truss to be placed when needed. At present a roadway 40 ft. between curbs and two 6-ft. sidewalks will be placed on the floor system between the arch ribs.

The arrangement of the roadway over, through and beneath the arch trusses is shown on the insert sheet accompanying this article. The bridge is symmetrical about the center line, except for the expansion details which occur at the eighth panel point on the Port Richmond side only and a braking girder arrangement at panel point 12 on the same side. Relatively short panel lengths are used, 40 panels at 41 ft. 3⅜ in. making up the length of the arch.

Bracing is liberal. The top chord and the web system of the arch trusses are relatively light, acting mainly as stiffening for the main arch rib, the lower chord; although near the center of the span, the stress line rises up from the arch rib into the web system. Single-triangle or K-bracing is used in the planes of both the top and the bottom chords except where interrupted for roadway clearance. Special bracing occurs at the portals, and vertical sway frames are used at panel points 0, 1, 2, 3 and 4. Bracing in the floor system is similar to that in the planes of the upper and lower chords, and wind chords are placed outside of the floor beams, consisting of 2-ft. square box-sections made up of two plates and four angles laced two sides.

Foundations—The foundations will not be difficult of design or construction, the subsurface conditions at the site being excellent for the needs of a huge arch. On the Port Richmond side a dense hard trap rock or diabase is found at depths varying from 18 to 24.5 ft. below mean low water. On the Bayonne side the same rock formation is found at still shallower depths, the minimum and maximum being respectively —10 and —14 ft. The overburden is largely silt and boulders.

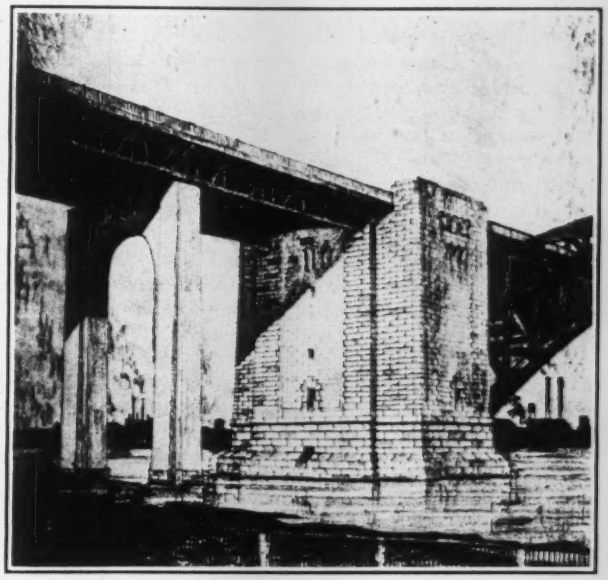


FIG. 3—PERSPECTIVE DRAWING OF ABUTMENT TREATMENT ON KILL VAN KULL BRIDGE

Foundation conditions are ideal, rock being comparatively near the surface. Above skewback, abutment consists of a steel tower framework used for erection purposes and later incased in concrete and the whole inclosed in granite. Approaches are steel girders on reinforced-concrete piers.

Both abutments are located in the water and will be constructed within double-wall steel sheetpiling cofferdams about 185x160 ft. with no interior bracing. The contract for the substructure includes only enough of the abutments to resist the arch thrust from the dead weight of the steel. After completion of this part of the abutments steel towers will be placed on them as a construction expedient, providing an immediate end support for the approach span. For esthetic reasons and to provide weight necessary to resist the additional dead-load and live-load thrust the steel towers will be inclosed with concrete and the whole faced with granite after the steel arch is erected. Under all conditions of erection the resultant thrust of arch and abutment weight is sufficiently near vertical to obviate any chance of sliding. Since bedrock is found at such shallow depths, it was comparatively easy to proportion the abutments so that the arch thrust enters the rock near the midpoint of the base. Details of the abutment are shown on the accompanying insert sheet.

A novel method for accurately setting the arch shoes is to be used. It includes steel frames, about 18x15 ft. in plan, set deep enough to secure adequate anchorage and concreted into the abutment, at the same time leaving a pocket about 30 in. deep beneath the top of the frame on which the shoe will rest. The built-up structural shoe of the arch will be riveted to this frame and the pocket subsequently filled with reinforced concrete to secure final bearing. The method was devised to eliminate the careful concreting operation necessary when the skewback face is finished to a perfectly plane surface accurately normal to the arch axis.

Arch Trusses—The bottom chord is the main arch member and carries all loads as a thrust into the skewbacks. It is therefore the largest member in the bridge, its maximum outside dimensions being 5 ft. 5 in. x 6 ft. 10 in. It is a nickel-steel double-box section with cover

plates top and bottom, a center web plate and the necessary reinforcing plates on the side webs and on the center web. The maximum section of the lower chord, in the first panel, has a gross area of 983½ sq.in. and carries a maximum stress of 27,923,000 lb. The minimum section, at the center, has a gross area 579.7 sq.in.

The upper chord, which with the web system functions mainly as bracing for the lower chord, is a silicon steel box-member with cover plates top and bottom having outside dimensions of 4 ft. 1 in. x 5 ft. 1 in. The maximum section in the upper chord occurs around the quarter point of the truss, being 385 sq.in. from panel point 9 to panel point 14; a compression of nearly 9,000,000 lb. is carried in these panels.

The verticals and diagonals of the web system are box sections of carbon steel consisting of four angles and two web plates with lacing on two sides. At panel

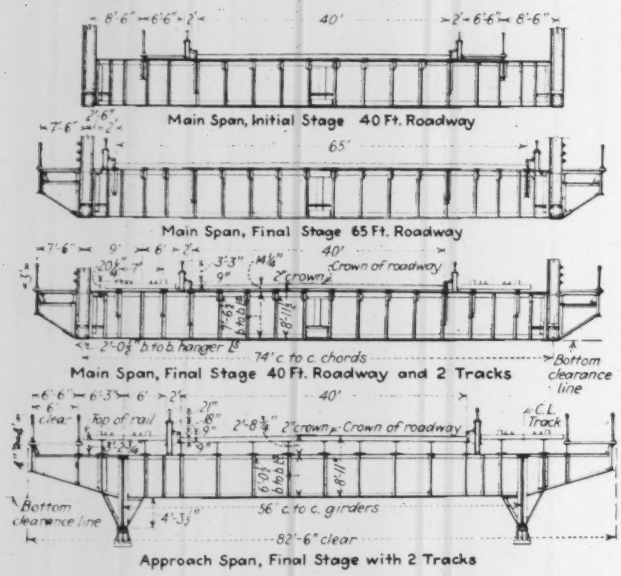

Main Span, Initial Stage 40 Ft. Roadway
Main Span, Final Stage 65 Ft. Roadway
Crown of roadway
74' c to c. chords
Bottom clearance line
Main Span, Final Stage 40 Ft. Roadway and 2 Tracks
Top of rail
C.L. Track
56' c to c. girders
82'-6" clear
Approach Span, Final Stage with 2 Tracks

FIG. 4—TYPICAL ROADWAY ARRANGEMENTS, INITIAL AND FINAL

point 6 the roadway hanger is a double-web member, joined by cover plates. All other hangers are built-up I-sections of a web and four angles.

The arch hinge constitutes one of the unusual details in the structure. Briefly, it consists of two heavy steel forgings bored for a 16-in. forged pin. The forging forming the upper half of the hinge is attached to the bottom chord through splice plates and clip angles fastened to the chord by rivets and to the forging by tap bolts. This forging is 3 ft. deep, with a cross-section just above the pin of 6 ft. 10 in. x 8 ft. The lower part of the hinge is a similar forging but is about 4 ft. deep and is connected to the structural steel shoe by tap bolts. The main advantage of these heavy and expensive forgings is that they insure positive and equal distribution of the arch thrust first to the full length of the pins and then to the four continuous webs of the shoes. As shown on the drawing, the shoes consist of these four webs separated by diaphragms and bearing on a 4-in. milled steel slab which rests on the skewback frames.

All connections and splices in the arch trusses are designed to develop the full strength of the members except splices at the milled joints in the lower chord, which are designed to develop only 60 per cent of the strength of the chord. Another exception is the connection of web members subjected to reversal of stress; these connections are designed for the sum of the stresses wherever this sum exceeds the full strength of the members. All lower chord and practically all upper chord gusset plates are 1-in. silicon steel.

Floor System—The layout of a typical floor system panel is shown on the insert sheet. The main members comprise two floorbeams 7 ft. 6¼ in. deep connected in a longitudinal direction by two girders, 5 ft. 8⅞ in. deep and 41 ft. 3⅝ in. long, located under the curbs of the initial 40-ft. roadway. The secondary system includes an intermediate floorbeam 5 ft. deep and four 21-in. 60-lb. beam stringers on each side of the center line between the main and intermediate floorbeams. Both the main and the intermediate floorbeams are silicon steel.

In addition to this floor system stringers are placed outside of the main longitudinal girders to support the sidewalks in their initial position. In the event that the roadway is widened or rapid-transit tracks are added, the sidewalks will be placed outside of the arch ribs on brackets, and these stringers will be moved to their final position between the brackets. The floor windbracing is of the K-type with wind chords at the ends of the floorbeams.

Special Details—The expansion and contraction movements of the floor system are provided for at panel point 8 on the Port Richmond side, although expansion is also possible at each end between the arch floor and the approach. The several details showing the necessary structural arrangement of sliding plates for the wind chord and the main longitudinal girders are shown on the insert sheet.

The braking truss is placed just inside of panel point 12 and was included in the design in view of the possibility of running rapid-transit trains on the bridge at some future date. Details of the braking truss arrangement are shown on the insert sheet.

Loads and Stresses—In the design of the arch trusses, dead-load, live-load, impact, temperature and wind were considered in various combinations. The live-load was assumed as two rapid-transit lines at 6,000 lb. per foot, four roadway lanes at 2,500 lb. per foot, and two sidewalks at 600 lb. per foot. This total live-load was reduced for the number of loaded lanes and the length of the load, with the result that with all 40 panels of the arch loaded the average live design load per foot was 5,260 lb.

Temperature stresses were assumed for variations of ±55 deg. F. and wind loads were assumed as follows: On upper chords, 450 lb. per foot of bridge; on lower chords, 800 lb. per foot of bridge; and on the floor system 750 lb. per foot of bridge, making a total wind load allowance of 2,000 lb. per foot of bridge. Loads for the arch bracing were assumed as combinations of wind, lateral force and longitudinal force. Wind loads as above were assumed. The lateral force was taken as 10 per cent of the live-load on two tracks and the longitudinal force as 20 per cent of the live-load on two tracks, not exceeding 1,000 ft. in length.

The dead-load of the arch and bracing is assumed to act on a three-hinged system with a hinge at the center of the span at joint L20. The dead-load of hangers, floor steelwork, tracks and pavement, which will not be added until the arch ring is completely swung, is assumed to act only on a two-hinged system. The arch trusses are cambered for dead-load deflections only.

The unit stresses for tension on net sections used were

as follows: Carbon steel, 20,000 lb. per sq.in.; silicon steel, 27,000 lb. per sq.in.; nickel steel, 33,000 lb. per sq.in. For compression on the gross sections unit stresses in tension were reduced as follows: for carbon steel, by 60 l/r with a maximum of 17,000 lb. per sq.in.; for silicon steel, by 80 l/r with a maximum of 23,000 lb. per sq.in.; and for nickel steel, by 100 l/r with a maximum of 28,000 lb. per sq.in. Shear on the gross section of the girder webs was assumed at 12,500 lb. per sq.in. for carbon steel, 17,000 lb. per sq.in. for silicon steel and 20,000 lb. per sq.in. for nickel steel. Values for bearing were, respectively: carbon steel, 30,000 lb. per sq.in.; silicon steel, 30,000 lb. per sq.in., and nickel steel, 50,000 lb. per sq.in. Power-driven rivets and bolts were given a design shearing value of 15,000 lb. per sq.in. and a bearing value of 30,000 lb. per sq.in.

Erection—The method of erection used will, of course, be determined by the contractor with the consent of the Port Authority's engineers. There are, however, several fixed conditions which the contractor must meet. The permit issued by the War Department for construction of the bridge defined a channel 510 ft. wide within which no obstructions will be permitted. The erection difficulties are further complicated by the fact that this channel is not in the center of the bridge but between panel point 7 on the Staten Island end and panel point 16 on the Bayonne end and that it passes under the bridge on a skew, making the total length of arch to be erected without falsework approximately 700 ft. The portions of the arch between the abutments and this channel will probably be erected as a cantilever.

Administration—The bridge is being built by the Port of New York Authority, of which John F. Galvin is chairman and J. E. Ramsey chief executive officer. The design and construction are being carried out under the direction of O. H. Ammann, chief engineer of bridges. E. W. Stearns is assistant to the chief engineer, L. S. Moisseiff is advisory engineer of design and Allston Dana is engineer of design. Traffic studies are carried out under Robert A. Lesher, traffic engineer, and field operations under W. J. Boucher, engineer of construction, and R. T. Robinson, resident engineer. Prof. William H. Burr, Daniel E. Moran and Joseph B. Strauss act as consulting engineers and Cass Gilbert as architect. Geological studies were made by Prof. Charles P. Berkey. The contractor on foundation work for the abutments is the H. P. Converse Company, Boston, Mass.

Giant Telescope for California Tech.

A great telescope of the reflector type with a mirror 200 in. in diameter, which will greatly surpass in power the present largest astronomical instrument in the world, the 100-in. Hooker telescope on Mount Wilson, is to be built shortly for the California Institute of Technology at Pasadena.

Concrete-Deck Timber Trestles on the Norfolk & Western R.R.

Wood Piles Carry Precast Slabs on Concrete Caps Cast in Place—Precast Concrete Parapets on Timber Decks

UNUSUAL combinations of wood piles and concrete slabs in trestle construction have been introduced in bridge-renewal work on the Norfolk & Western Railway. In brief, these structures consist of creosoted pile bents with concrete caps cast in place and carrying precast slabs for the deck. The details of construction vary in different structures.

It is considered that the concrete deck and caps give a more permanent structure at little additional cost above that of a ballasted-floor creosoted timber trestle. Creosoted timber piles are used instead of concrete piles, because the railway company has its own creosoting plant, and the piles as delivered on the job cost 35c. to 40c. per linear foot, whereas reinforced-concrete piles delivered would cost $1 to $1.50 per linear foot. In addition, it is not considered practicable to apply swaybracing to the concrete piles.

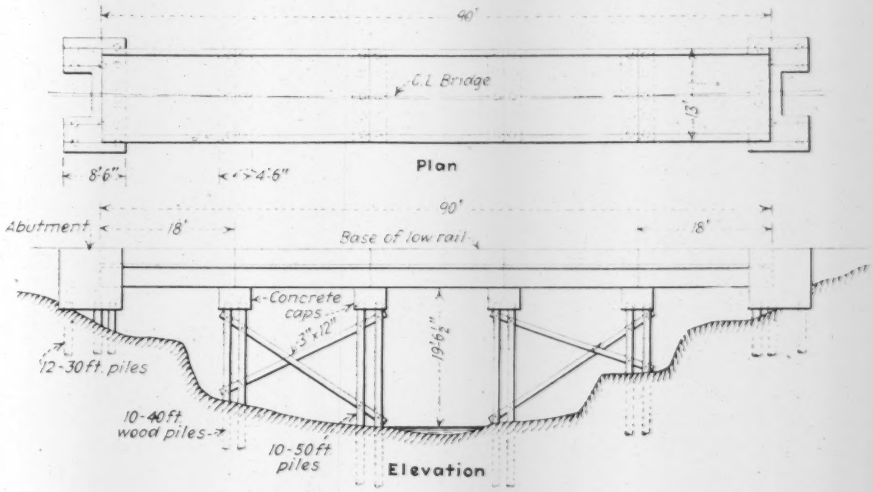


FIG. 1—WOOD PILE BENTS WITH CONCRETE CAPS AND DECK

With creosoted timber decks on ballasted trestles there has been some trouble with caps and piles decaying on the inside, due to water getting in along the drift bolts. On this account it has been necessary in many cases to cut off the piles, replace them with posts on sills and put on new caps. Decay of the creosoted piles occurs also from cutting off the pile to proper height when driven, thus exposing the untreated center. Coating the fresh surface with creosote is only partly effective as a protection. With the concrete cap poured in place and incasing the head of the pile to a depth of 12 in., it is expected that the ends of the piles will be sealed effectively, so that water will not reach the heart of the pile. It is thought that wood piles properly creosoted and capped with concrete will last at least 30 or 40 years.

Trestles are designed for Cooper's E-70 loading, and with a timber-ballasted deck of 12-ft. spans the load per bent is 208,000 lb., or about 35,000 lb. per pile in a six-pile bent. With a concrete-ballasted deck of 18-ft. spans

on double pile bents, the load is about 322,000 lb. per bent, equivalent to 32,200 or 36,000 lb. per pile with ten-pile or nine-pile bents respectively. Double bents are necessary in order to carry caps of the necessary width. Thus with increased span the load per pile is reduced in the concrete-deck design.

T-Beam Slabs for Trestles—In rebuilding the trestle bridge No. 1897, over Bull Run near Walnut Cove, N. C., on the line to Winston-Salem, five spans were provided, with bents of creosoted piles on which concrete caps were cast in place to carry precast concrete deck

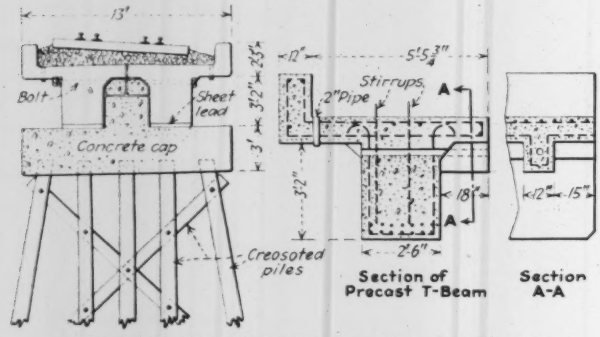


FIG. 2—TRESTLE SPANS OF PRECAST T-BEAMS

slabs of T-section. The general design is shown in Fig. 1, with details in Fig. 2. Stone ballast is used and gives the necessary superelevation, as the trestle is on a 4 deg. curve.

Each bent consists of two rows of piles, 30 to 50 ft. long, driven to carry safely a load of 40,000 lb. per pile. Each bent has swaybracing, and there is longitudinal bracing in two of the spans. The concrete cap is 3x4½ ft. in section, the bottom covering the pile heads for a depth of 12 in. and the top having at the middle a stem or stub to serve as a separator for the beams of the slabs. Each reinforced-concrete T-beam, 18 ft. long, comprises a girder or beam about 30x48 in., a 10-in. deck slab and a curb wall or parapet for the ballast. The end slabs have also a transverse curb to retain the ballast at the bridge seat. No filling or calking was placed in the longitudinal or transverse joints.

At each end of the beam is a shoe of ½-in. steel plate, 24x28 in., having riveted to it four inclined straps or anchors which are embedded in the concrete. The shoe rests on a lead plate $\frac{1}{10}$ in. thick, 27x30 in., which is laid on the concrete caps and is held in place by the weight of the slabs. Loop rods provide for handling the slab and are left in place, buried in the ballast, to allow for any future adjustment or replacement. (On some roads such loops are burned off when the slabs are in place.) Vertical 2-in. cast-iron pipes provide for drainage. Horizontal 2½-in. pipes are embedded in the concrete to receive a 2-in. through bolt at each end, holding the two slabs together. These bolts, fitted with nuts and locknuts, are given a coat of red lead and three coats of black bridge paint before being placed.

For this structure the poured-in-place concrete for the caps was a 1 : 1¾ : 3 mix, made with crushed limestone and 6 gal. of water per bag of cement. For the precast slabs, the mix was 1 : 2½ : 3, made with the same stone and 6½ gal. of water per bag. The average crushing strength of ten test cylinders was 2,350 lb. at seven days and 3,460 lb. at 28 days.

Flat-Slab Trestle Deck—In renewing the trestle approaches to bridge No. 2040, a 520-ft. steel viaduct near Winchester, Ohio, each approach was made with two 18-ft. spans back of the old abutments, on account of settlement of the fills behind the abutments. In this case (Fig. 3) the poured concrete pile caps on the double pile bents are of plain rectangular section, 3x4 ft., and 13½ ft. long. Each 18-ft. span consists of a pair of slabs 35 in. thick at the middle and 31 in. at the ends, to allow for drainage, and having a curb wall along one side. Stone ballast is laid.

Concrete poured in place for the caps and abutments was a 1 : 2 : 4 mix, while a 1 : 2.5 : 3.6 mix was used for the precast concrete. The tops and ends of the slabs were given two coats of bituminous waterproofing. Expansion filling was placed in the transverse joints, while the longitudinal joint was calked with oakum saturated in asphalt. No metal bearing shoes are used under these flat slabs, as with the T-beam slabs, but just before placing the slab the top of the concrete cap is given a coat of 1 : 2 cement mortar, made with an early-strength cement.

The concrete slabs of 16-ft. span on the walls of the old abutments were poured in place, using an early-strength cement, as this work was done under traffic. A transverse curb at the end of the slab retains the ballast, so that it cannot spill over the bridge seat.

Concrete Caps—Wood forms for the poured-in-place concrete caps on the creosoted pile bents were supported

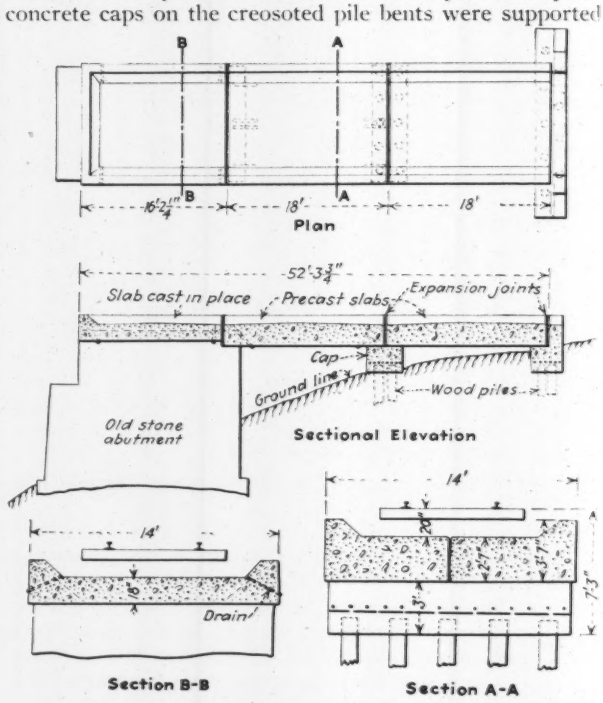


FIG. 3—WOOD AND CONCRETE BRIDGE APPROACH

by timbers bolted to the two outside piles and the middle pile. The holes in the former piles were used for bolting the face bracing after the forms were removed, while the hole in the middle pile was closed with a plug of creosoted wood. These forms were left in place for seven days and each form was used twice. A ½-yd. mixer and a temporary house for cement storage were placed at the end of the bridge, the concrete being placed in the forms by means of buggies and chutes. These traveling concreting gangs averaged ten men.

Concrete Parapets on Timber Trestles—Another application of precast concrete on this road consists of

concrete parapets to retain the ballast on solid-floor timber trestles. At bridge No. 588, a 125-ft. steel truss bridge near Durham, N. C., the approaches are timber-ballasted solid-floor pile trestles, 126 ft. and 287 ft. long. These trestles consist of 12½-ft. spans, with four vertical and two batter piles in each bent. All bents have sway-bracing, while longitudinal diagonal bracing is placed in alternate spans. On the caps are twelve lines of stringers 8x16 in., with a 3-in. plank deck for the ballast.

On each side of this deck is the parapet, consisting of precast concrete slabs or beams 12x18 in. in section and 7 ft. in length, each beam weighing about 1,550 lb. In each beam are cored three holes and sockets for ¾-in. bolts, which pass through the plank floor and the outside or jack stringer. To provide for drainage, each beam is seated on three pine blocks 2 in. thick, 10x18 in., these being placed at the bolts.

In each end span the timber stringers rest on blocking on the concrete pier carrying the truss bridge. To retain the ballast on the deck of the approach, a concrete curb or parapet is placed across the end of the deck, filling the space between the concrete parapets along the sides. This end parapet is a concrete beam 12 ft. 11 in. long, 21 in. wide and 11½ in. thick, having three cored holes for bolts attaching it to the plank floor. Upon this slab is laid a standard bridge tie, 8x10 in. and 12 ft. long, to carry the track rails. These parapets are of 1 : 2 : 4 concrete, made with stone of 1½-in. maximum size.

All piles and timbers in this structure are creosoted. When their ends were cut off in erection, the surfaces were given at least three coats of hot creosote oil, each to be absorbed entirely before the next coat is applied.

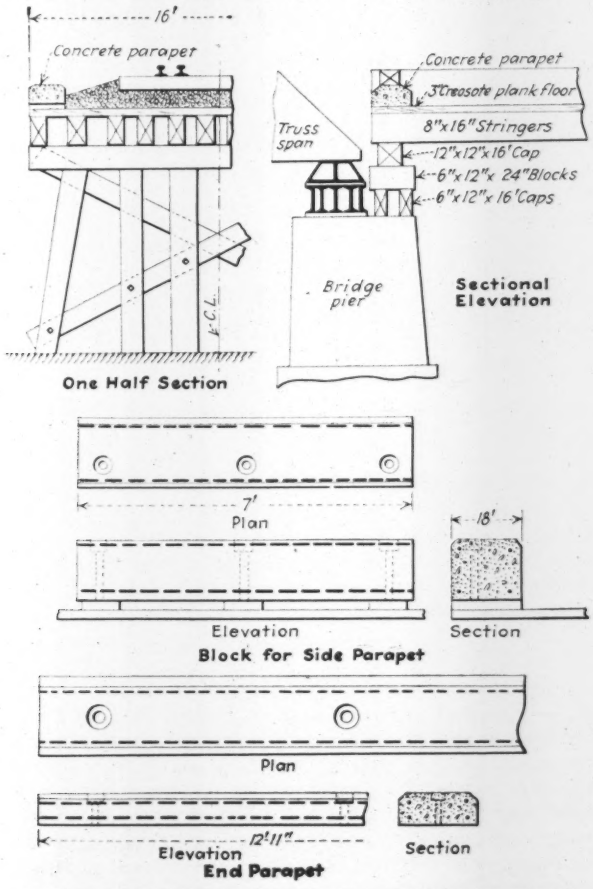


FIG. 4—CONCRETE PARAPETS ON TIMBER TRESTLE

Concrete Deck Construction—Where concrete caps are used in trestles, it is considered absolutely necessary that they should be cast in place, whether on wood or concrete piles, in order to insure a good job. This work, as done by the railway's bridge and building department, is not very expensive. On the special caps for T-beam spans, described above, the cost was about $21 per cubic yard in place, including steel reinforcement. For the caps of simpler design, also described, the cost would be less.

Precast concrete flat slabs have been used on a number of bridges and trestles between Portsmouth and Cincinnati, Ohio, and in the yards at Portsmouth. All of these were made at Portsmouth, hauled to destination on flat cars and placed by means of a derrick car or locomotive crane. The T-beam slabs mentioned were made at Roanoke, Va., shipped on flat cars to destination and placed with derrick cars.

Concrete for precast slabs is a 1 : 2½ : 3 mix, made with broken stone and based on the water-cement ratio. Each 18-ft. T-beam slab contains 10 cu.yd. of concrete and weighs 41,500 lb. complete. Each 18-ft. flat slab contains 13½ cu.yd. of concrete and weighs 55,200 lb. But although the T-beam design is lighter and has less concrete, its formwork is more expensive and the through bolts add to the cost of making and placing, so that the flat-slab design is being used in preference. Field concrete work is done by company force, using small portable mixers as described.

The designs described were initiated by W. P. Wiltsee, chief engineer, Norfolk & Western Railway, and were worked out by L. L. Kelly, bridge engineer, the latter being also in charge of the construction work by the railway's bridge and building department.

Vehicle-Miles

BY AN ingenious method of calculation the writer of an unsigned article in the *Bulletin* of the Minnesota Federation of Architectural and Engineering Societies has deduced that about one-half the total vehicle mileage in Minnesota is made on the trunk highways. The argument is made apparently as a basis for a plea for a greater allocation of money to the trunk system. At present, it is stated, considerably less is spent on the trunk system than on the state aid, county and town roads.

The details of the calculation follow: There are 650,000 cars registered in Minnesota and they travel an average of 5,000 miles a year. The latter figure is confirmed both by general experience and by an analysis of gasoline consumption. This would make a total travel of 3,250,000,000 vehicle-miles, which may be considered a fair total of the travel on all roads and streets in the state. Tourist traffic of outside cars is nearly compensated by the mileage of Minnesota cars outside the state.

By using the highway department's traffic census and multiplying the average number of cars going past each checker by the number of miles in the trunk system, it is found that Minnesota cars rolled up a total of 5,523,000 vehicle-miles every day and tourists from other states another 1,435,000 miles, making 6,958,000 vehicle-miles as the daily traffic burden on the trunk highways. Making an allowance of 25 per cent reduction in home travel and 75 per cent for tourist travel to allow for the winter influence, it is found that Minnesota cars cover a total 1,500,000,000 miles and foreign cars 150,000,000 miles on the trunk highways in a year. The resulting 1,650,000,000 vehicle-miles is about half of the total travel of 3,250,000,000 vehicle-miles, as given above.

Improving the Water-Works System of Evansville, Ind.

Economic Studies for Reservoir Capacity and Pumping Machinery—New Pipe Lines to Distribution System

By F. M. Veatch and H. F. Lutz
Of Black & Veatch, Consulting Engineers, Kansas City, Mo.

IMPROVEMENTS now being made to the water-works system at Evansville, Ind., have the dual purpose of reducing operating costs and anticipating for approximately ten years the increasing demands of this rapidly growing city. The work, which will cost about $1,000,000, includes: (1) Construction of a 20-m.g. covered concrete storage reservoir on high ground north of the city, together with two supply lines from this reservoir to the distribution system; (2) rehabilitation of pumping station; (3) improvements to filter-washing equipment. A general plan is given in Fig. 1.

The water supply of Evansville is obtained from the Ohio River and is treated in a purification plant which consists of mixing basins, coagulation basins and rapid sand filters. The original plant was constructed in 1912, and additions were made in 1918 from designs by Alvord, Burdick & Howson, of Chicago. The present population, including suburban territory, is approximately 106,000 and the population actually served by the water system is estimated at 100,000. The future population, as indicated by past growth and by school enrollment and public utility use, is approximately 125,000 for 1937 and 150,000 for 1947.

The present rate of water consumption, as shown by meter records, is approximately 9, 12 and 20 m.g.d. for average day, maximum day and maximum hour, respectively, corresponding to 90, 120 and 200 gal. per capita. For 1947 the consumption is estimated at 11.25, 15 and 25 m.g.d. respectively. The distribution system is well laid out and is of ample capacity, but is handicapped by the fact that the sole source of supply is from the pumping station. Pressures fluctuate quite widely, particularly in the outlying sections. Tests indicate that owing to poor conditions the steam consumption of the plant, based on 1926 conditions, is approximately 90,000,000 lb. per year and that this can be reduced to approximately 60,000,000 lb. per year by the proposed improvements.

Studies for Improvements—In the selection of pumping equipment and the determination of clear-water storage required, a study was made of the practice in American cities of over 60,000 as regards pumps. Data on these matters from 29 cities were obtained. Fig. 2 represents the total capacity of the installations of pumping equipment of four types, and indicates plainly that the recent trend has been toward steam turbine-driven centrifugal pumps, with motor-driven centrifugal pumps second. The number is sufficiently large to give a true indication of practice. Fig. 3 represents the storage in 29 cities, expressed as a percentage of the average daily pumpage.

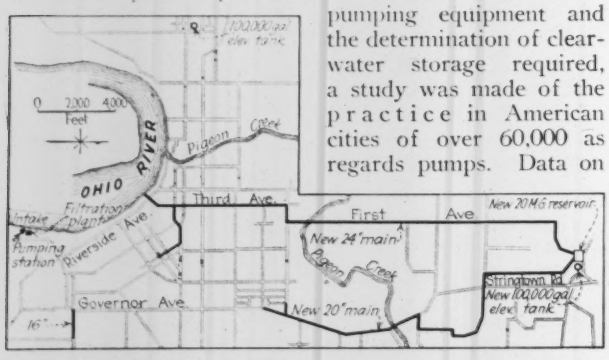


FIG. 1—WATER-WORKS IMPROVEMENTS AT EVANSVILLE, IND.
New outlying reservoir has two pipe lines to distribution system.

The required reservoir capacity for 1947 conditions is as follows: Theoretical storage required to equalize pumpage, 2.7 m.g.; allowance of 100 per cent for reservoir fluctuation, 2.7; allowance of 10 per cent of filter capacity to allow for units out of service, 1.8; fire demand of 11,000 g.p.m. for ten hours, 6.6; total, 13.8 m.g. Capacity of present clear-water reservoir, 1.8. Total new storage required, 12 m.g. As some of these factors are uncertain, it was decided to build a 20-m.g. reservoir.

This reservoir (Fig. 4), located on high ground north of the city, will be a concrete structure, about 360 ft. square and 25 ft. deep. The sidewalls will be of the cantilever type for a depth of 15 ft. and the lower 10 ft. will have sloping walls. A concrete slab roof supported by columns will be covered with 2 ft. of earth. The inlet and outlet pipes are fitted with check valves, so that the water will enter the basin through inlet pipes located along two walls and will be drawn off through one pipe which extends through the reservoir at its central point. Two cast-iron supply mains, one 20-in., 20,400 ft. long, and one 24 in., 25,000 ft. long, are being laid to connect with the distribution system.

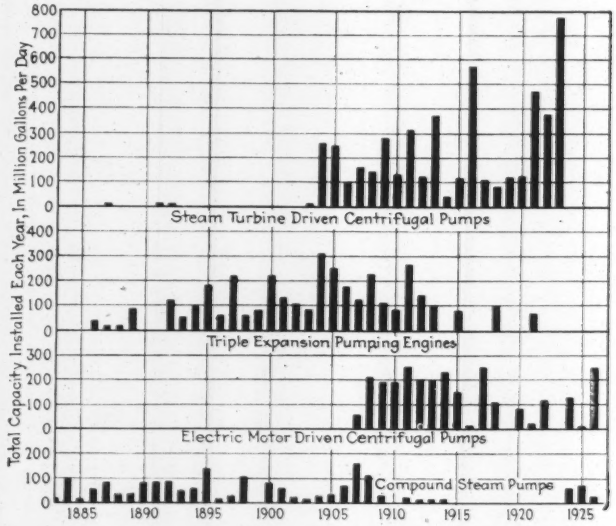


FIG. 2—DEVELOPMENTS IN USE OF PUMPING MACHINERY
Annual installations of four types of pumps, 1883-1926.

Pumping Station—The existing pumping station was built in 1898, at which time raw Ohio River water was pumped into the city mains by two 10-m.g.d. vertical triple-expansion pumping engines, located in a pit 55 ft. in diameter and 61 ft. deep. These two pumps are still operating, but for high-service duty, since with the installation of the first units of the purification plant in 1912 two 15-m.g.d. steam turbine-driven centrifugal pumps were installed in the pit for low-service duty and the piping was rearranged to allow the vertical pumps to take suction from the clear-water reservoir. At the same

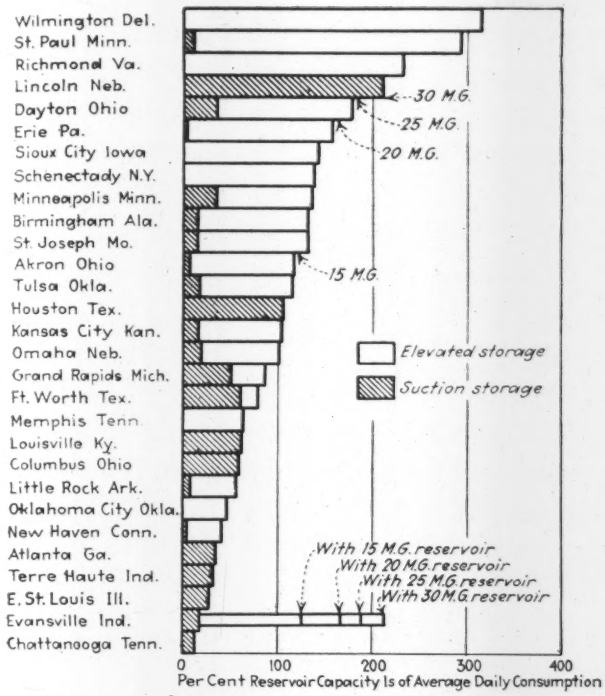


FIG. 3—RESERVOIR STORAGE IN SEVERAL CITIES
Capacity given as percentage of average daily consumption.

time two 15-m.g.d. steam turbine-driven units were installed for high-service duty.

The pump pit, of stone masonry, rests on a timber crib which served as a shoe during construction. This pit is a monument to the engineering skill and judgment of the late Charles Hermany, who designed it and supervised its construction. During the installation of the low-service pumps the cribbing was cut, with the result that it leaks badly. It is also too small to accommodate any additional equipment of the type now in use for either high or low service. The floor, 8 ft. thick, built up of 12x12-in. oak timbers, is subjected to a static head of 15 to 56 ft., depending on the river stage. In recent years it has sprung several leaks in inaccessible places, but the rearrangement of equipment will clear the floor of obstructions and allow it to be repaired.

New Pumping Equipment—The two existing 15-m.g.d. steam-driven centrifugal low-service pumps will be replaced by three motor-driven centrifugal units operating on alternating current at 440 volts and with capacities of 20, 12 and 8 m.g.d., respectively. The principal reason for this selection was the small floor space required. With the present type of equipment it is impossible to install the needed additional capacity without undue congestion. It was much more economical to change to a different type of equipment than to provide additional floor space at this low elevation for steam turbine-driven equipment.

The two existing vertical triple-expansion high-service units are being put in first-class condition. New auxiliaries are being installed on two 15-m.g.d. steam turbine-driven high-service units and one new 20-m.g.d. steam turbine-driven high-service unit is being installed. A careful comparison between steam turbine-driven centrifugal pumps and reciprocating pumping engines was made. The much lower first cost of the steam turbine-driven installation was the greatest factor in the selection of this type. Fuel is comparatively low in cost at Evansville and the lower steam consumption of the triple-expansion engine was not so important as it might have been with higher fuel prices.

Electric Power—Comparisons between purchased power and generation of electric energy for low-service pumping showed no outstanding difference in cost of operation between the two methods. Final decision resulted in the selection of a steam engine-driven generating plant. This decision was made largely on account of the factor of safety afforded by duplicate generating units at the plant as compared with transmitted power.

Boiler Plant—The boiler plant, with three 260- and one 306-hp. water tube boilers, is being improved by the installation of chain-grate stokers, water softener, coal- and ash-handling equipment, new boiler-feed pumps and boiler-room instruments. In the past it has been necessary to shovel the coal twice and also to shovel the ashes twice. The new system will eliminate this labor.

Filter-Wash Pumps—Wash water was taken formerly from the high-service mains, through a wash-water tank

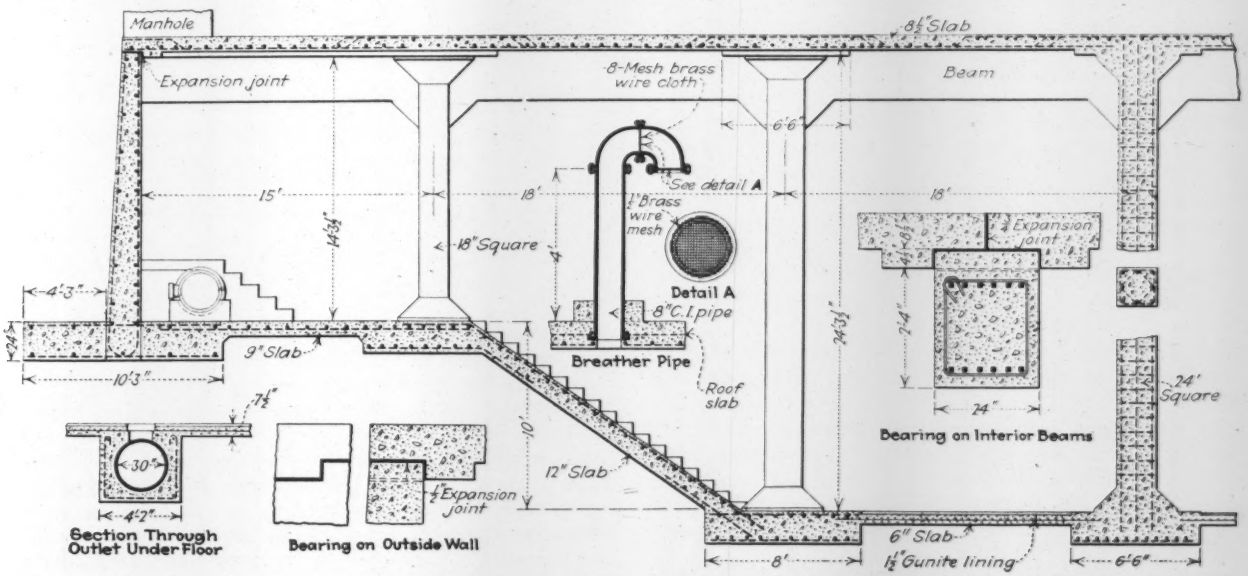


FIG. 4—NEW 20-M.G. RESERVOIR, EVANSVILLE, IND.

with an available capacity of 44,000 gal. Under maximum conditions the drain on the high-service lines amounts to 3.74 m.g.d. It is proposed to install a 1,500-g.p.m. centrifugal wash-water pump to take suction from the clear-water reservoir; it will be direct-connected to a water turbine operated from the high-service line, and will discharge into the wash-water line. In this way the draft on the system will be reduced to 2.16 m.g.d. and the energy in the water used will be utilized to its fullest extent.

Engineers and Contractors—Plans and specifications for this work were prepared by Black & Veatch, consulting engineers, Kansas City, Mo., and construction is in progress under their supervision. The project was financed by and is being carried out under the direction of the city's department of water-works. Charles Anderson is general superintendent. Contracts awarded in March, 1928, total $862,197; the items include $304,765 for the reservoir, $169,873 for cast-iron pipe, $105,429 for pipe laying and $43,740 for pumps. Contractors for construction work are as follows: reservoir, Shofner & March, Springfield, Ill.; pipe lines, Whitmire Construction Company, Kansas City, Mo.; additions to pumping station, A. Phelps & Son, Detroit, Mich.

Significant Tests of Frost Action on Concrete

Tests Indicate Importance of Initial Curing at High Temperatures in Cold-Weather Concrete Construction

By William H. Batchelder

Assistant Engineer of Tests, Minnesota Highway Department, St. Paul, Minn.

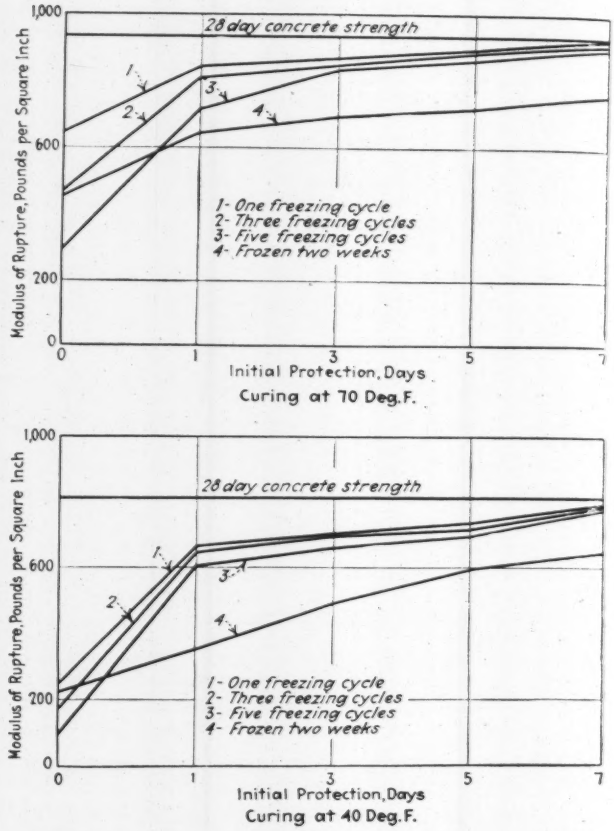
TESTS in the Minnesota Highway Department laboratory give a definite idea of the magnitude of the harm done by freezing and the protection necessary before concrete can be safely exposed to freezing weather. They were run in two series:

1. Specimens were cast in a room maintained at 70 deg. F. and with all materials at 70 deg. F. Except when exposed to freezing temperatures they were cured under wet burlap in a room maintained at 70 deg. F. The beams had no covering when they were exposed to freezing.

2. Specimens were cast in a room maintained at 40 deg. F. and with all materials at 40 deg. F. Except when exposed to freezing temperatures they were cured under wet burlap in a room maintained at 40 deg. F. The beams had no covering when they were exposed to freezing.

The beams in each series were subjected to the following conditions: (1) Exposed to freezing for fourteen days, (2) exposed to freezing for sixteen hours, (3) exposed to three freezing cycles, (sixteen hours freezing and eight hours curing), (4) exposed to five freezing cycles and (5) cured for 28 days. In all the freezing tests the beams were exposed (*a*) immediately after casting, (*b*) one day after casting, (*c*) three days after casting, (*d*) five days after casting and (*e*) seven days after casting. All beams were broken when 28 days old. The results of the tests are shown by the accompanying graphs.

It is evident from a study of these test results that



EFFECT OF INITIAL CURING BEFORE FREEZING ON STRENGTH OF CONCRETE

Each point is average of four tests on two 6x6x30-in. beams; mix 1 : 2 : 3; aggregates natural sand and traprock.

freezing immediately after casting is the worst condition that might occur. In series A one freezing causes a 31 per cent drop in strength; in series B a 69 per cent drop. If the concrete is protected for seven days these percentages are reduced to 0 and 3.5 respectively. These figures disprove conclusively the theory that concrete is not harmed by frost immediately after casting if subsequently given adequate curing.

Curves 1 and 2 show the decisive gain in strength by good curing immediately after casting. Concrete is not greatly harmed by frost after 24 to 72 hours' curing if subsequently given good curing.

Two weeks' freezing has little if any more effect than one freezing except, of course, the concrete gains no strength when frozen.

The effect of alternate freezing and thawing is shown by the distance between curves 1, 2 and 3 on the graphs. This effect is high if freezing is started immediately after casting and decreases with additional initial curing. The effect is less in series B also due to the fact that eight hours under wet burlap at 40 deg. F. was insufficient completely to thaw the beams and they were not really subjected to alternate freezing and thawing.

These test data should serve to impress engineers, architects and contractors with (1) the necessity for initial curing at relatively high temperatures for cold-weather concrete; (2) the necessity for excluding the period concrete is frozen from the age of concrete when estimating strength and when loading the structure, and (3) necessity for a longer curing period when the curing temperatures are low.

How Traffic Congestion Is Fostered by Control Measures

Observations on Street Conditions in Denver Reveal Clogging of Traffic by Prohibitions Against Use of Car Track Space Opposite Safety Zones, by Unusual Signaling and by Double Parking

By W. W. De Berard
Associate Editor, Engineering News-Record

How Much Traffic Congestion is caused by the very agencies designed to expedite traffic or to increase safety? This question is in the minds of many users of the streets, including motorists, pedestrians and riders on the street cars. Accordingly the present article endeavors to portray somewhat in detail the conditions existing in a city of average size that has no traffic engineer to give it expert advice but has relied on its staff of elected officials and its police department. Traffic is handled about as efficiently as in the average municipality. The following analysis of certain factors in the situation is intended not as a captious criticism of Denver's work with the traffic problem but as a picture of what may be found in hundreds of cities throughout the country. Overnight the traffic problem has come upon these cities, and the best of experts find their abilities taxed.

—Editor.

Congestion and inefficient street use within the central district are evils in many of our cities today. They are apparent in a typical way in Denver, Colorado's metropolis of 300,000 population. Three factors primarily contribute to this condition. They are, first, safety zone restrictions; second, an unusual setting of the stop-and-go signals, and third, double parking resulting from lax parking regulations. So far there has been no searching investigation of these traffic difficulties by any local agency, but several unco-ordinated private agencies are working on the problem. Surveys and traffic counts have been made by the City Planning Commission; they have been directed mainly toward physical improvements rather than to operation of existing facilities.

Some $60,000 has been spent on stop-and-go signals for the central business district. The company which made the installation set the timing on a basis of two successive lights green and the next two red. Excessive zeal on the part of the safety council, aided by the street-car company, has resulted in an extensive layout of wide safety loading zones for street cars in the business district. Due to the large amount of curb space given over to long-time parking, too little curb loading space is left, and in consequence there is an excessive amount of double parking and of cruising.

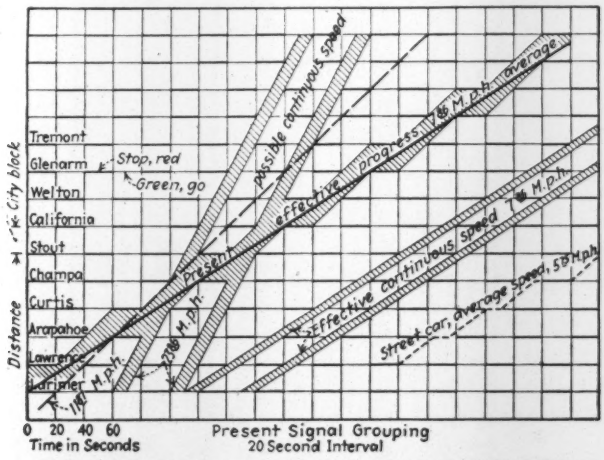


FIG. 1—TRAFFIC SPEEDS ON NUMBERED STREETS
Present signal operation on a 40-second cycle, evenly split east and west and north and south, grouped in twos, operated as a reversed synchronized system, gives a maximum of 25 per cent efficiency

Safety Zone Operation—Much adverse criticism has arisen over the question of driving to the left of safety zones set apart at street intersections for loading and unloading street-car passengers. A street-traffic ordinance requires all vehicles to pass to the right of safety routing markers. Inasmuch as this rule prohibits following street cars and limits the fluid traffic to one lane near street intersections, where the storage capacity of two lanes should be available, the reasonableness of the requirement to stay off the car tracks is under investigation by the Retail Merchants Association.

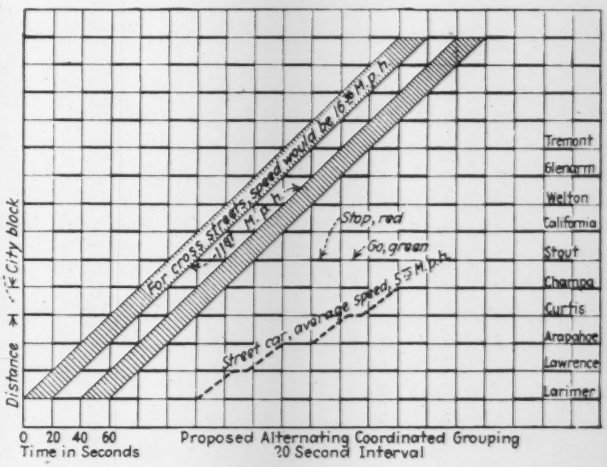


FIG. 2—PROPOSED ALTERNATING CO-ORDINATED GROUPING
Proposed signal operation on a 40-second cycle, evenly split between east and west and north and south, at each intersection instead of in groups of two, would give a maximum of 50 per cent efficiency and increase speed from 7.86 to 11.87 m.p.h.

The manager of safety, R. W. Hershey, states that utilization of this portion of the street is prohibited because it is his understanding that the majority of the cities of the country follow this practice. Since the ruling was made on the "comparative" basis and not on the basis of benefits accruing to the street cars in expediting loading and shortening the running time (as was done in Kansas City), the merchants set out to learn what other cities are doing. A questionnaire sent to similar retail organizations in 41 cities produced the following results:

Sixteen cities do not permit driving on street-car tracks to the left of safety zones; nineteen do; six belong in neither group. In the first group, sixteen, nine cities report that there is room for two cars between the safety zone and the curb. This means that the Denver class (single fluid lane) has but seven other cities, or 17 per cent of the total. Of the six cities which fall in neither group, four have no safety zones, one has no safety zones downtown and the sixth permits automobiles to drive on the car tracks when no one is standing in the safety zone. Five should therefore be added to the nineteen car-track users, making 24, or 59 per cent of the total of 41 cities, that permit car-track driving at intersections. The cities are listed in the following table:

Nineteen Cities Permit Use of Car Tracks to the Left of Safety Zones

Cincinnati	Milwaukee	Portland, Ore.	St. Louis
Columbus	Omaha	Sacramento	San Francisco
Des Moines	Pasadena	Seattle	Washington
Detroit	Philadelphia	Sioux City	Wilkes-Barre
Los Angeles	Pittsburgh	Springfield, Mass.	

Sixteen Cities Prohibit Use of Car Tracks to Left of Safety Zones

In Nine, Two Cars Can Pass Between Safety Zone and Curb		In Seven, Only One Car Can Pass Between Safety Zone and Curb	
Akron, Ohio	Cleveland	Baltimore	Minneapolis
Atlanta	Dayton, Ohio	Canton, Ohio	Toledo
Birmingham, Ala.	Rochester, N. Y.	Kansas City, Mo.	Tulsa
Boston	Salt Lake City	Memphis	(Denver)
Buffalo			

Oklahoma City permits automobiles to drive on street-car tracks when no one is standing on the safety zone. Nashville has safety zones but not downtown. New Orleans, Providence, R. I., Spokane and Trenton, N. J., do not have safety zones.

The street-car company, in answer to the criticism of so much occupancy of street floor space, adduced figures which indicate that there are in the central business district 78,572 lin.ft. of curb available for parking, which at 15 ft. per car would allow for 5,238 cars. Excluded curb length opposite the safety zones is only 4,717 ft., or 6 per cent, plus 1,800 ft., or 2.3 per cent, of prohibited parking within 30 ft. of property lines at street-car stops, representing 314 and 120 car capacities respectively. In terms of street area, the safety zones (measured from outside of buttons to center of street) occupy 2.3 per cent of the total, while parked automobiles occupy 24.3 per cent, leaving 73.4 per cent available for the fluid traffic.

Figures of the daily number of passengers carried on the street cars (on June 30, 1927, 87,495 rode into the district) are given as 182,000 in and out, as against 220,000 total entering the district by all agencies. Carrying such a large percentage of the total load, the car company feels justified in occupancy of such a small percentage for loading safety zones. The motorists' objection is to continual occupancy when these zones are not in use. These comparative figures led to further study by the merchants to find the riding habits of shoppers.

Shoppers' Riding Habits—As to the number of patrons of the stores (not the public generally) that use automobile transportation, the results of 1,944 answers to 10,000 postcards to families sent out by the merchants indicate that 65.7 per cent use automobiles, while only 34.3 per cent use the street cars. The result is so astounding as compared with one-third this percentage found by surveys in Detroit and in Chicago that the officials do not consider it conclusive. However, as no other statistics are available at the moment, the figures of this survey are pertinent.

It was carried out by using an existing map showing the number of families in the various sections of the city. This map was divided into eleven districts, and the 71,400 families instead of the total population were used as the basis for the apportionment of the 10,000 cards. In addressing the cards a directory of householders was available. In most cases cards were limited to two to a block, although occasionally there were four to a block, including both sides of the street.

Nearly 2,400 cards were returned, but only 1,944 were so marked as to permit analysis by districts, and showed that the relative use of automobiles and street cars is fairly uniform; for example, the percentage of those who use automobiles varied only from 60 to 68 per cent in the larger near-by districts. In two of the high-grade residence districts of Park Hill and Country Club the automobile-using percentage rose to 79 and 82 per cent.

No attempt has been made by the retail merchants to work out what are the riding habits of other than shoppers, and in consequence the figures are not comparable with the Detroit and Chicago figures, which were the results of cordon counts of all persons entering the central business districts. But the merchants seem to have shown that Denver shoppers do not use street cars to anywhere near the extent ordinarily supposed, and

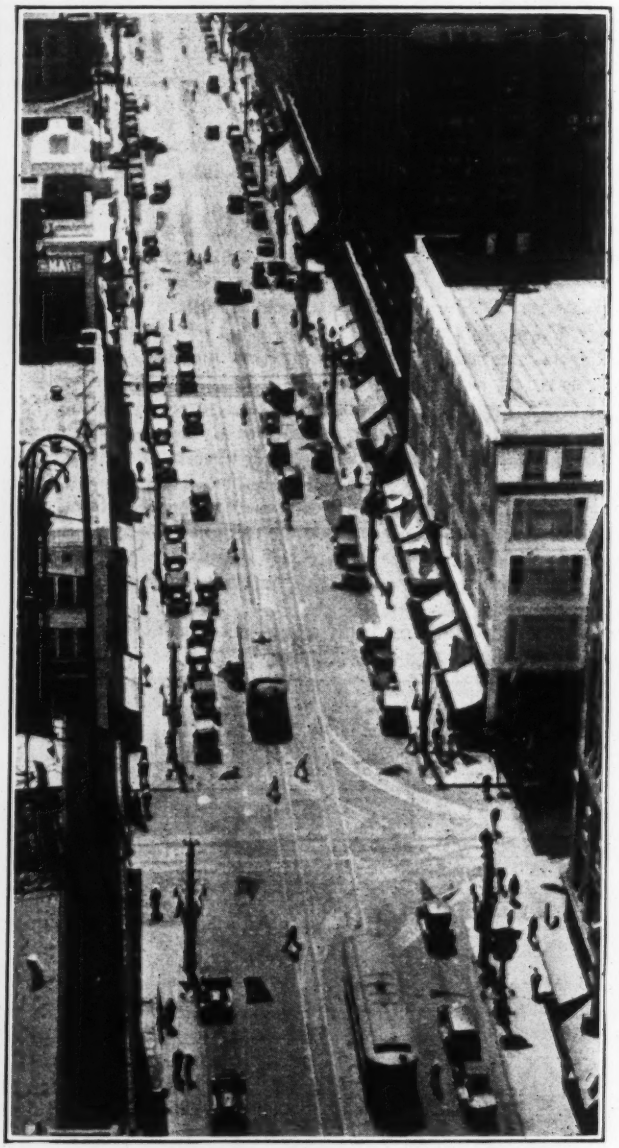


FIG. 3—SIX-LANE RETAIL STREET CUT TO TWO LANES
Looking southeast up Sixteenth St., Denver, from Arapahoe. No autos use the car tracks and the safety zones force the fluid lane to bend to the curb.

therefore they argue for as much traffic efficiency as possible.

Permission to drive on the car tracks would double the storage space for automobiles waiting at a red signal, and would permit an intersection to double its efficiency, whereas at present, when the single line of stored cars often extends backward beyond the middle of the block, about the fifth car in the line does not reach the intersection before the succeeding red signal flashes. What the engineers originally designed as a six-lane traffic (48-ft. roadway on 80-ft. streets) becomes a poor, sinuous two-lane trafficway. Parked vehicles take up one lane near the curb, and the street cars and their loading zones use two lanes each way in the center of the street.

The time-saving per run to the street cars is gain for their 182,000 patrons, and this should be balanced against the loss of time to the motorists. Both agencies of transportation are essential, and true efficiency can be obtained only through consideration of the greatest good to the greatest number. Arbitrary rules for peak-load conditions, however, may well be altered to meet off-peak conditions.

It is significant, the merchants state, that Denver has 220,000 people, nearly 70 per cent of the total population, entering and leaving the business district each day, as against Chicago's 894,000, less than 30 per cent of the total population. Since many of the traffic figures are fragmentary and conclusions on them are likely to be erroneous, the merchants are contemplating the expenditure of $10,000 for a traffic survey for the business district.

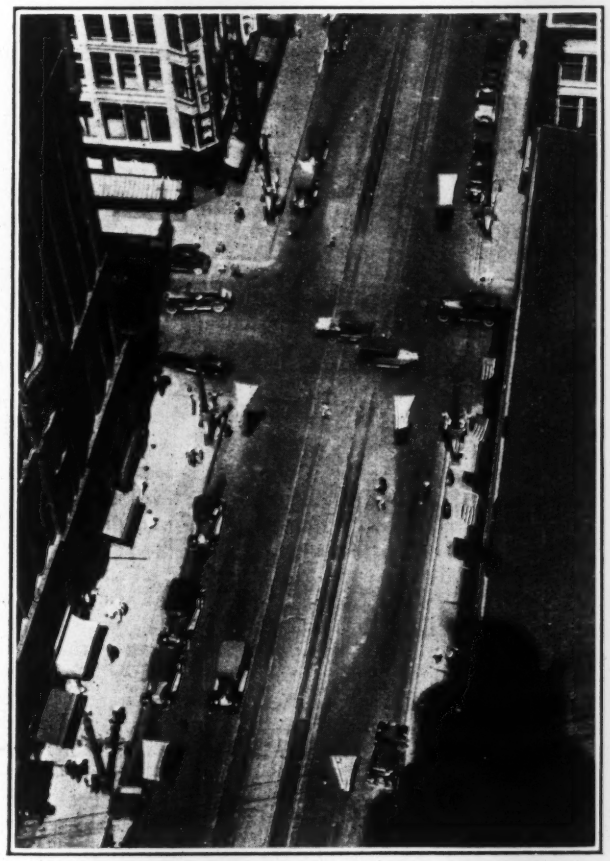


FIG. 4—OIL MARKING SHOWS LIMITED PAVEMENT USE
Looking northwest down Sixteenth St., Denver, from Lawrence.

FIG. 5—DOUBLE LANE ALONGSIDE SAFETY ZONE MARKED BUT NOT USED
Example of laning where two cars can pass between curb and safety zone, but motorists use only one lane.

Other traffic irregularities noted in Denver, which may or may not have been copied from other cities, are as follows:

Signs are used to indicate where a left turn may be made, rather than, as usual, serving the opposite function of denoting where left turns are prohibited. This comes from the traffic ordinance, which prohibits all left turns at intersections "controlled by a traffic officer or electric signal between 8:30 a.m. and 7 p.m., Sundays included." The wholesale prohibition, with exceptions only as signed, is most confusing to the tourist driver. But Mr. Hershey states that tourist violations of any of the traffic ordinances are negligible; it is the home people, who should know the rules, that are the violators.

Double Parking—Double parking in Denver is one of the most serious sources of congestion. In San Francisco double parking was the greatest contributory agency of traffic congestion before the comprehensive survey called for enough loading zone space to care for the terminal requirements of the cars entering the central business district (*Engineering News-Record*, Oct. 11, 1928, p. 536). Casual observation during a couple of hours' cruise of the Denver business district on a weekday will disclose 175 to 200 double-parked autos and trucks. Apparently the police are lenient, and perhaps must be, in view of the small amount of space devoted to loading only and the non-observance of the loading-space signs.

By ordinance, parking of unattended vehicles is prohibited along the curb where designated and marked in front of school property, theaters, banks during banking hours, hotel entrances, entrance of any building three stories or more high, any building where public gatherings are being held and within 5 ft. of a hydrant.

The curb length given over to loading, fifteen-minute parking, is approximately one-sixth of the curb along car-track streets and is equivalent to not more than one-tenth of the total curb length in the central business district.

As 100,000 automobiles enter the district daily and less than 4,800 cars can park at one time under the general 60-minute restriction, equivalent to a maximum of 48,000 autos in a ten-hour day, space for unloading or terminal facilities for the remaining 52,000 must be provided.

Assuming an average of fifteen-minute parking in the unloading space and every space filled for five hours, (50 per cent efficiency) there is required 39,000 ft., or

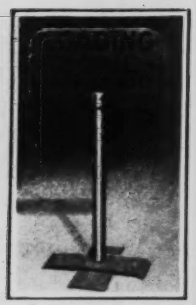


FIG. 6—LOADING ZONE SIGN TO CONTROL SPACE BETWEEN BACK END OF STREET-CAR SAFETY ZONE AND ALLEY
From four to six cars can park fifteen minutes back of this sign to the alley. Further back, from the alley to the next street, seven cars can park, making a total of eleven to thirteen cars per block on each side.

at 15 ft. a minimum of 2,600 berths, about one-half of the total available space. This indicates the reason for much unnecessary cruising to locate a parking space, and for the large amount of double parking.

S. R. DeBoer, consultant to the City Planning Commission, attempted to work out a rational time of parking to suit the character of business of the street: One hour for department-store streets, one-half hour for bank streets, and one hour plus for a wholesale street. But he soon found too many complications in designating such streets, to say nothing of enforcement difficulties.

Signal Setting—Another traffic deterrent in Denver is the platoon system of signal grouping (two intersections green and two succeeding ones red), which gives only a possible 25 per cent efficiency, as shown in Fig. 1. A 50 per cent efficiency is shown as possible in Fig. 2, which could readily be effected by an alternating co-ordinated grouping. These charts were worked out by Nelson P. Love, chief engineer of the street-car company, and the change has been urged by the local engineering societies. In the electrical hook-up there are two centrally controlled circuits; in consequence an alternating co-ordinated grouping, but not a progressive grouping, can easily be obtained by interchanging the red and green glasses in every second pair of signals or by changing the wiring in four signals only. The short time-interval, with equal allotment to main and cross streets, is probably the best arrangement for the average Denver intersection, though undoubtedly the requirements at certain outlying intersections are quite different from any possible to obtain without a more elaborate wiring installation.

Results—Accident results from the traffic regulations in Denver are not as yet encouraging. Capt. M. Y. Chapman, in charge of the accident records in the police department, gave the following comparative figures for number of accidents for the first three months of 1927 and of 1928:

Item	1927	1928
Personal injury	316	398
Property damage	1,775	2,012
Total	2,091	2,410

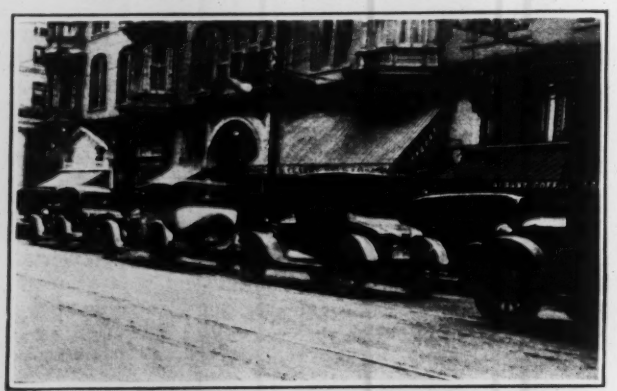


FIG. 7—AT SIGNAL STOPS THE FIFTH OR SIXTH CAR OFTEN DRIVES ONTO THE STREET-CAR TRACK AND BLOCKS IT

About one-third of the signal system was installed in 1926 and the remainder in 1927. Captain Chapman is of the opinion that the above figures do not correctly indicate the conditions, and that fewer accidents are now happening than previously, because with the recent regulations requiring both parties to an accident to report under penalty of fine many accidents that previously would not have found their way into the records are now

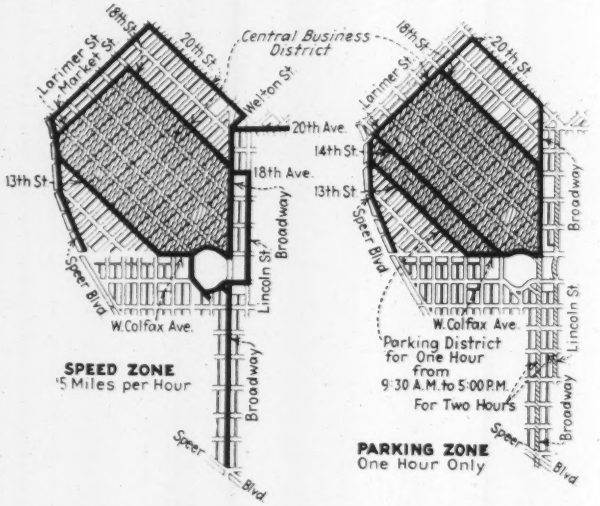


FIG. 8—SPEED AND PARKING ZONES DEFINED
The central business district for which street-car company gave figures on relative space used for parking, loading street cars in safety zones, and fluid traffic.

reported. Further, it is his opinion that the increase in number of accidents is not in the downtown district covered by signals.

A "cafeteria court" is maintained, where violators may plead guilty and pay fines without delay; 4,183 violators paid $17,094 in 1927.

To sum up, Denver may be said to have ample equipment for traffic control, but the operation of that equipment leaves much to be desired. Its stop-and-go signals are but 25 per cent efficient and they easily might be 50 per cent efficient. Street-floor use is materially restricted by safety zones, long-time parking and double parking. Its accident record shows no improvement in 1928 over 1927.

New Soil Moisture Data Bearing on Depth of Irrigation

Experiments on irrigated test plots were carried on near Prosser, Wash., during the past few years by the U. S. Department of Agriculture to obtain data on soil moisture as affecting the proper depth of irrigation. The soil was a sandy loam with moisture equivalent to 16 per cent; it was capable of holding 16 in. of water in the upper 6 ft., and when all available water had been absorbed by a crop it still contained 5 in. water in the same layer. In ordinary irrigation practice water would be applied when the moisture in 6 ft. has been reduced to about 10 in. If only 4 to 6 in. of water is applied in each irrigation, it is therefore unlikely that any effective leaching can occur. The authors (C. S. Scofield and C. C. Wright, in *Journal of Agricultural Research*, July 15, 1928) conclude that in order that leaching of the root zone may occur to prevent accumulation of the salt contained in the irrigation water, it is necessary to apply more water than is customarily used.

Report on Boulder Dam

Board of Engineers and Geologists Finds Project of 550-Ft. Dam Feasible—Conservative Design Recommended—Cost Estimate Increased

An inquiry into the feasibility of building a 550-ft. dam in Boulder Canyon on the Colorado River; a review of the plans and estimates prepared by the Bureau of Reclamation for such a dam to form a storage reservoir of 26,000,000 acre-ft. capacity and a power house and an irrigation canal.

Discussion of the engineering and economic features of the proposed work by a board of engineers and geologists consisting of Major Gen. William L. Sibert, Charles P. Berkey, Warren J. Mead, Daniel W. Mead and Robert Ridgway. Dam sites in both Black and Boulder Canyon considered.

REPORTING on the feasibility of the Boulder dam project, a board of engineers and geologists appointed under a resolution of Congress passed last May declares the contemplated high dam in the Boulder Canyon region of the Colorado River to be feasible from an engineering point of view. Its report, dated Nov. 24, was laid before Congress on the opening day of the current session, Dec. 3. The board consisted of Major Gen. William L. Sibert, chairman; Charles P. Berkey and Warren J. Mead, geologists; and Daniel W. Mead and Robert Ridgway, engineers. Their report is unanimous.

The board's inquiry included an examination of the site of the dam, a study of data on the river, and a review of the Reclamation Bureau's designs for the dam, the power plant and the All-American canal to the Imperial Valley. The instructions of the board were to review the plans and estimates made for the dam and to advise the Secretary of the Interior as to matters affecting the safety, the economic and engineering feasibility and adequacy of the proposed structure and incidental works (the latter being understood to be the power house and its equipment).

Black Canyon Site—As dam sites both in Boulder Canyon and in Black Canyon have been under discussion heretofore, the board examined both locations, and found them both feasible for the construction of a dam 550 ft. high to impound 26,000,000 acre-ft. of water. At the Boulder Canyon site the foundation rock is granite, at Black Canyon cemented tuff. The Black Canyon site is considered preferable, however.

The most favorable location in Black Canyon is about 40 miles distant from Las Vegas, Nev., and the Union Pacific Railroad. The approach is comparatively easy to the vicinity and not particularly difficult to the site itself. A construction railway from Las Vegas would pass near available gravel deposits and the best quarry sites lie immediately adjacent to the dam site on the same line of approach. Despite the ruggedness of the surrounding country and the depth of the gorge, the terrain above the 1,500-ft. contour, where the quarries, railway yards, shops and camps would be located, is open, and its development into such use at reasonable cost is entirely practicable.

The canyon walls at this site rise to about 900 ft. above the river, and the central part of the rock gorge at this location is 110 to 127 ft. deep below low water. The cross-section of the gorge at the dam site is 350 ft. wide at the low water line and 880 ft. wide at the crest of a dam that would impound 26,000,000 acre-ft. of water.

The foundation is a volcanic breccia, or tuff, originally an accumulation of fragments of many kinds derived from volcanic eruptions and now transformed into a well-cemented, tough, durable mass of rock standing with remarkably steep walls and resisting the attack of weather and erosion exceptionally well. The whole rock mass is essentially impervious.

The rock formation is somewhat jointed and exhibits occasional fault displacements, which are now completely healed. It is an almost ideal rock for tunneling, is satisfactory in every essential and is suitable for use in construction.

The associated rock formations at higher levels, more advantageously situated for development for construction uses, are also volcanic in origin, including both andesite flows and indurated andesitic tuffs, and are of excellent quality for that purpose. Near by there are deposits of angular gravels that have been proved by test to be suitable for use in construction.

There is no doubt whatever that the rock formations of this site are competent to carry safely the heavy load and abutment thrusts contemplated. It is well adapted to making a tight seal and for opposing water seepage and circulation under and around the ends of the dam. It insures successful tunneling and, so far as the rock is concerned, the general safety and permanence of the proposed structures.

Earthquake Hazards—In former geologic times this district was subjected repeatedly to volcanism and deformation, says the board, but the region has been virtually undisturbed for a very long time. "The conclusion is that danger from local earthquakes of enough violence to threaten a properly constructed dam in Black Canyon is negligible."

Design of Dam—A more conservative design than that heretofore considered by the engineers of the Bureau of Reclamation is proposed by the board. Both the bureau and the board favor the gravity type, but the former used allowable stresses as high as 40 tons per square foot, whereas the board considers a lower pressure desirable.

The dam proposed by the Bureau of Reclamation and assumed to be the one referred to in H.R. 5773, is of the gravity type, curved in plan, with allowable stresses as high as 40 tons per square foot.

It is the opinion of the board that a dam of the gravity type is suitable for the site in question and that such a dam built across Black Canyon would be safe, provided the maximum stresses allowed do not exceed those adopted in standard practice.

Maximum foundation and structural stresses have until late years been limited, in the best practice, to about 20 tons per square foot. Until perhaps twenty years ago this practice was regarded as standard. The demand for high dams at reasonable expense has, however, induced more economical designs, and such stresses have been increased to 30 tons per square foot in numerous structures which have been in use a sufficient period to cause this practice to be considered conservative. Stresses in excess of 30 tons cannot be considered conservative in a structure of this unprecedented magnitude and importance, failure of which would result in such an overwhelming disaster.

In consideration of these facts and possibilities, it is the judgment of the board that the dam should be designed for maximum calculated stresses not exceeding 30 tons per square foot. This will add materially to the cost of the dam, which increase will be included in the estimates.

Cofferdam and Diversion Tunnels—For construction of the dam, the Bureau of Reclamation proposed to build two rockfill cofferdams, between which the dam was to be built, and to divert the flow of the river around the site by three tunnels 35 ft. in diameter, to carry 100,000 sec.-ft. This provision the board considers inadequate, and recommends increasing the diversion capacity to 200,000 sec.-ft. It also recommends modifications in the cofferdam construction and a lower height of temporary impounding, to avoid danger downstream in case of failure.

As to possible flood flows, the board says: "Floods

reaching a maximum flow of 380,000 sec.-ft. have been reported, and old high-water marks are said to indicate a possible flood flow of as much as 500,000 sec.-ft. The board is of the opinion that water in quantity should not be permitted to flow over a dam of this type." Accordingly, a larger spillway capacity is recommended than the 110,000 sec.-ft. provided in the bureau plans.

Construction of the power house below the dam is also considered feasible and to "offer no particular difficulties."

All-American Canal—The proposed canal to supply water to Imperial Valley, extending from an intake at Laguna dam (23 miles by river above the present intake of the Imperial Canal) through the sand hills region lying between the river valley and the east slope of the Imperial Valley, is reported to be feasible, in the following statements:

Between the Colorado River and Imperial Valley the canal location, for a length of 10 miles, crosses a region of sand dunes, some of which reach a height of about 150 ft. above the canal bed. For much of this distance the canal cut will be over 50 ft. deep. The grade of this section of the canal is such that the water surface will be below the mesa level and hence below the bases of the sand dunes. Winds above a velocity of 10 miles an hour cause a movement of the surface sand, which increases with the velocity of the wind, and special provision should be made to prevent undue silting of the canal by the blow sand, as well as for the removal of the sand that will drift into the canal prism. In order to observe conditions the board visited the sand dune belt several times, once during a sandstorm. Although it is clear that difficulties are presented by the drifting sand, it is the opinion of the board that it is feasible to construct, maintain and successfully operate the canal. The overcoming of these difficulties will affect the cost, which has been allowed for in the estimates.

The cost estimates heretofore advanced, containing an item of $31,000,000 for this canal, do not include the northward extension of this canal to the Coachella Valley, and the board estimates on this extension separately. Cost figures are given farther on.

Effect of the Storage Project—The board discusses the equalizing and flood-reducing effects of the project as a whole in the following section:

A dam of 550 ft. above low water across the Colorado River at Black Canyon, impounding 26,000,000 acre-ft. of water, will be adequate, in the opinion of the board, to so regulate the flow of the lower Colorado as to control ordinary floods; to improve the present navigation possibilities; and to store and deliver the available water for reclamation of public lands and for other beneficial uses within the United States.

The high-water flow of the flood of 1884 is reported to have been 380,000 sec.-ft. Such a flood, or one of greater magnitude, is to be expected. The flood of 1884 is the highest concerning which there is fairly definite information, and as far as can be ascertained such a flood has occurred but once in the last 50 years. A flood of this magnitude could be so controlled at the dam as to limit the flow in the river below to about 160,000 sec.-ft. Should such a flow sweep down the lower Colorado River following a long period of normal regulated flow, with the consequent encroachment of vegetation on the flood plain and the probable neglect of flood-protection works, it would be more destructive than a 160,000-sec.-ft. flood under present conditions. It should be noted that the Boulder dam project in no way affects the flood discharge of the Gila River. In the event of flood damage in the lower river valley from either river, regulation at the dam would permit repairs to be made on the return of a controllable flow.

Water Supply—In a lengthy discussion of the total flow of the Colorado River the board comes to the conclusion that the figures heretofore used by the Bureau of Reclamation have been too high, both because the long-time gagings made at Yuma "are at least 10 per cent too high" and because (as brought out some years ago by Herman Stabler, of the U. S. Geological Survey) there was a long cycle of low stream flow in the latter part of the last century. In consequence the board concludes:

The records of past performance of the Colorado River and of such streams in this vicinity as seem pertinent furnish no basis for an exact estimate of long-past flows in the Colorado River. There is naturally considerable leeway in the interpretation of these data, and estimates based thereon may differ materially. The board, however, realizes that in determining the economic feasibility of this project its estimates should be on the safe side, and it has consequently adopted the following figures for the flows at Black Canyon, without further depletion:

	Acre-Ft.
Average low flow for a period of 15 to 20 years...	10,000,000
Average high flow for a similar period.....	14,500,000
Average of high and low periods.....	12,250,000

It is estimated that the present flow is depleted by water taken for irrigation in the upper basin by approximately 2,750,000 acre-ft., which amount if added to the above estimated average flow would increase it to about 15,000,000 acre-ft. This is the amount apportioned by the Seven States Compact for division at Lee's Ferry.

Main Findings:

Construction of a dam in Black Canyon rather than Boulder Canyon recommended and found to be feasible and safe.

More conservative design and larger flood provision recommended.

Construction and maintenance of the All-American irrigation canal found to be feasible.

Southern California will be able to absorb power developed at the site.

Cost of dam, power plant and canal put at $165,000,000 and construction period at seven years.

Salts and Silt—Discussing the effect of the reservoir overflowing lands along the Virgin River which contain beds of sodium chloride, sodium sulphate and calcium sulphate, the board concludes that "the actual salt content will not be increased to an injurious amount, even in the beginning, and that in a comparatively short time the incoming silt will be so effective in blanketing the salt deposits that the salt content of the river waters will be reduced to about the present amount."

Annual silt deposition in the reservoir is placed at the figure of 137,000 acre-ft. per year. As a result of this deposition, "it appears that approximately three-fourths of the effective reserve capacity for irrigation and power will still be available at the end of the first 50-year period and that a slightly larger proportion of the flood reserve capacity will still be available."

Complete silting of the reservoir would require about 190 years.

The board considered the likelihood that the desilted water discharged from the reservoir would pick up silt in its course below the reservoir and concludes that if such picking up occurs it will soon reach a natural limit.

Power—Under present conditions of irrigation, the board finds, a continuous output of 550,000 hp. could be maintained even during the years of normal low flow. But, because of irrigation developments, "within a 30- or 40-year period, even with a re-regulating reservoir, the power output may be reduced to five-tenths or six-tenths of the capacity of the proposed plant during a long dry period."

This whole matter is further complicated by the proposed Seven States Compact. It is quite probable that the compact attempts to apportion more water than the actual average undepleted flow of the river. The situation is still further complicated by the fact that the upper states are authorized to take more than an equitable proportion of the flow of the river, for any one or more of a series of dry years, provided they permit a total of

75,000,000 acre-ft. to flow down the river in a period of ten consecutive years.

In any event, the upper basin has, by virtue of its location, first call on the water of the river. The withdrawal of the allotted share of the annual flow during any series of years of low flow may make it impossible to carry out the terms of the compact during the latter part of a low ten-year period. If the low flow continued for a considerable term of years, the proposed storage at Boulder dam would be inadequate to provide sufficient water for the lower valley through such a period. The power output would also be seriously affected and might be reduced below the estimated minimum previously stated.

A 1,000,000-hp. hydro-electric plant fully loaded and operating continuously on a 55 per cent load factor would generate annually 3,600,000,000 kw.-hr. of current. In actual practice this theoretical output might be reduced by approximately 10 per cent.

With the uncertainties of the flow at Boulder dam, it is impossible to estimate closely the average annual output of power which would obtain during a 50-year period.

Conclusions—The economic questions underlying the project are reported upon as follows:

The time available for the investigation in preparation of this report has not been sufficient to permit the board to go into all phases of this subject in the detail necessary to fix its findings with the degree of exactness which might otherwise be practicable.

The board believes, however, that it has been able to review the available data with sufficient thoroughness to warrant the conclusions expressed in this report.

In considering the economics of this project the board recognizes the importance, among others, of the following factors:

1. While much land has already been brought under irrigation on the Colorado River delta in Mexico, it is evident that such development has been retarded by the lack of water available from the river during low-water periods. The storage of flood water in the Black Canyon reservoir and its release during low-water seasons will make more water available in Mexico and will invite immediate expansion in irrigated acreage in that country. With the limited water supply available from the Colorado River, every acre permanently irrigated in Mexico will mean that an acre in the United States cannot be irrigated. Such a limitation on lands would result in a corresponding limitation on possible income. It is the opinion of the board that it is of much economic importance in this project that an agreement limiting the amount of water assignable to Mexico should be made prior to the completion of the Boulder Canyon project.

2. The board believes that the growing demand for power in southern California, when considered on a conservative basis, will be sufficient to absorb the probable power output of the proposed hydro-electric plant.

3. As a sound basis for estimating the probable power output of a stream, it is necessary to know the flow of the stream for a long term of years covering periods of low and high flow of sufficient duration to furnish the low, average and high flows for which the plant must be designed. Any less complete data throw doubt on the estimate, which becomes serious in proportion to the uncertainties in the data and the magnitude of the investment.

When this project was first proposed the cost of steam power in southern California was such as to leave a reasonable margin of profit above the probable cost of hydro-electric power generated at the proposed power plant. With the reduction in costs of power generated by steam, this margin has been greatly reduced.

The operation, maintenance, interest and sinking fund for the Boulder Canyon project must be paid from the sale of power and of storage services, which latter has been estimated at $1,500,000 per annum by the Secretary of the Interior.

Based on the foregoing and the shortage of power which will occur at low flow, the board is of the opinion that if the Boulder Canyon project is completed and put in operation, carrying as it does the costs of flood-protection works and the All-American canal, it will be impossible to meet operation, maintenance, interest and a sufficient sinking fund to retire the cost of the project within a 50-year period.

4. It is obvious that the power which can be generated from Boulder dam is a valuable resource. If the income from storage can be reasonably increased and the capital investment reduced by the cost of the All-American canal, together with a reduction for all or a part of the cost properly chargeable to flood protection, it would be possible to amortize the remaining cost with the income from power.

Revised Cost Estimates—The cost of the project as given by the board, revised from the figures of the Bureau of Reclamation, is as follows:

Estimated Cost	
Dam and reservoir (26,000,000 acre-ft.)	$70,600,000
1,000,000-hp. development	38,200,000
The All-American canal	38,500,000
Interest during construction on above	17,700,000
Total	$165,000,000

In this revision stresses in the dam have been limited to a maximum of 30 tons per square foot, and a diversion capacity of 200,000 sec.-ft. is provided. A canal to Coachella Valley would increase the above estimates by $11,000,000, making the total $176,000,000. All these figures are based on a construction period of seven years.

Specifications for Steel Pipe for Wanaque Aqueduct

Bids Asked on Seven Types From 30-Ft. or 7½-Ft. Plates With Base Size 74 In. and Differentials Up to 78 In. on Riveted

SPECIFICATIONS for the Wanaque aqueduct, bids for which are to be opened on Dec. 20, as outlined in our issue of Dec. 5, p. 854, are of unusual interest both in themselves and on account of the long controversy as to the kind of material on which bids would be permitted that has been going on for several years past, as noted from time to time in this journal (summarized briefly, with references, at the close of this article).

The aqueduct is to be built for Newark and Paterson and six other municipalities by the North Jersey District Water Supply Commission as agent. It will be about 20 miles in length, not including tunnels already built, but as its upper end will consist of twin pipes, the total length will be 164,100 ft. The aqueduct will extend from the Wanaque impounding reservoir at Midvale, already built, to the existing reservoir of the city of Newark in Belleville. The contract with the two municipalities calls for a capacity of 150 m.g.d. at the upper end and 97 m.g.d. at the lower end, but does not specify the material to be used. Both the upper twin tubes and the lower single pipe will have a diameter of 74 in. if lock-bar or hammer-welded pipe, or riveted pipe from 30-ft. plates, with countersunk rivets, is used, with longitudinal differentials up to 78 in. in size for five different types of riveted pipe. The lock-bar and hammer-welded pipe will be fabricated from 30-ft. plates. The riveted pipe may also be so fabricated or it may be from 7½-ft. plates joined to make 30-ft. lengths. Of the total length of 164,100 ft. of pipe, including the twin section, at least 158,050 ft. will be composed of $\frac{7}{16}$-in. pipe, and 160,950 ft. may be of that thickness, leaving 2,200 ft. in one case and 6,100 ft. in the other to be of thicker plates—either $\frac{1}{2}$ or $\frac{9}{16}$ in. (For tabulation of diameters, plate lengths and thicknesses for the seven types of pipe on which bids are invited, see *Engineering News-Record*, Dec. 6, 1928, p. 844.)

The contract will also include a small amount of pipe of various connections, Venturi meters, manholes, highway, river and railroad crossings. The main items total some 34,000 tons of steel pipe, about 400,000 cu.yd. of earth excavation, some 10,000 cu.yd. of rock excavation, about 100,000 cu.yd. of borrow and some 330,000 cu.yd. of refill and embankment.

The specifications state: "Bids from contractors not experienced in the kind of work required or from un-

seasoned, new and temporary organizations shall not be considered. The contract will be awarded to the lowest responsible bidder, who in the judgment of the commission is qualified to do the work, and the commission reserves the right to reject any or all bids, and to waive informalities."

The entire work must be completed within 21 calendar months after the contractor is served notice by the engineer to begin work. One of the two twin lines must be completed to a point where it crosses the Pequannock line of the city of Newark within seven months, subject to liquidated damages against the contract at the rate of $600 a day not as penalty but for "loss of ability to serve Wanaque water under emergency or other conditions to participating or related municipalities"; ten months' time is given for completing one of the two pipe lines as far as the intake channel of the Passaic Consolidated Water Company, subject to liquidated damages of $1,200 a day; all pipe lines and appurtenant work must be completed sufficiently to deliver the full carrying capacity of the aqueduct to the various municipalities within eighteen months, subject to liquidated damages at the rate of $3,000 a day; if the work is not entirely completed within 21 months, the contractor shall be liable to liquidated damages at the rate of $200 a day.

A general requirement for all steel plates and rivets is that they "shall be made by the basic open-hearth process." The rivets must comply with Standard Specification for Boiler Rivet Steel, serial designation A31-24, American Society for Testing Materials. Other requirements for plates varying with the type of pipe are mentioned farther on. All longitudinal seams shall be of either lock-bar, hammer-welded or double-riveted steel.

Hydrostatic tests of the finished pipe in the shop shall be made under a pressure of 175 lb. per sq.in., and field tests under 125-lb. pressure, the latter to show not over 8,500 gal. leakage per mile of pipe per 24 hours in any section tested.

After cleaning in the shop, each fabricated 30-ft. length of pipe is to be heated and coated and then wrapped. Before coating, the pipe must be heated to 350 deg. F. The coating shall be either "Hermastic" or "Ovarco" or else "other material equal thereto and satisfactory to the engineer." For coating, the pipe is to be dipped vertically into the coating bath heated to from 400 to 450 deg. F. The coating must have a uniform thickness of not less than $\frac{1}{32}$ in. The coated pipe is to be covered "with 'Pabco,' Soil-Proof Wrapped, or other material equal thereto." This wrapping is described as "felt, which has been thoroughly saturated with a high melting point bituminous compound." The wrapping material must weigh not less than 3.6 lb. per square yard. To the outer surface of the wrap flaked mica must be applied "in such quantities as to give satisfactory results." The wrapping is to be applied spirally to the pipe under a tension of not less than 50 lb. per 18-in. width of wrapping. The wrap must overlap at least $\frac{1}{2}$ in. During the wrapping process, "hot dip shall be poured continuously as the pipe is rotated in such quantities as to firmly and truly seal the wrap to the surface of the pipe at all points." At each joint the ends of the wrapping must be finished by "sealing with hot dip." Field joints are to be wrapped with a strip "long enough to give a 6-in. circular lap and a 6-in. longitudinal lap." Here also there must be hot dip applied and a sealing of the joints.

After each section of the pipe has been finished, inspected and tested for tightness, it must be sterilized with "chlorinated lime, generally known as 'chloride of lime' or 'bleach' of approved quality . . . mixed with water, the quantity of chlorinated lime for any section being at least at the rate of $2\frac{1}{2}$ lb. per 100 lin.ft."

Working strength for joints is to be assumed as follows: Plate, 15,000 lb. per sq.in. in tension and 10,000 lb. in shear; rivets, 9,000 lb. in single shear and 22,500 lb. per sq.in. in bearing. For lock-bar and hammer-welded pipe, joint efficiencies shall be at least 90 per cent, while for riveted joints the efficiencies shall be "approximately the maximums obtainable when using the above-stated working strengths." For lock-bar steel pipe, the plates shall conform with "Standard Specifications for Boiler and Firebox Steel for Locomotives Flange Quality, Serial Designation A30-24," Am.Soc.T.M. Steel for the lock-bar pipe shall be "extra soft with an ultimate tensile strength between 40,000 and 50,000 lb. per sq.in."

Hammer-welded steel pipe must be made of plates conforming to "Standard Specifications for Grade A Steel Plate of Flange Quality for Forged Welding Without the Addition of Flux, Serial Designation A89-27," Am.Soc.T.M. There shall be not over two plates of 30-ft. length joined longitudinally by welding with a mechanically driven hammer. After welding has been completed, the pipe shall be placed in an annealing oven until the steel is heated to an orange color and thoroughly annealed in order that all strains may be removed, the temperature being brought to at least 1,750 deg. F. for a required length of time.

Countersunk-riveted steel pipe, in 30-ft. lengths, shall be of no more than two plates, with longitudinal double-riveted lap joints, the heads of the rivets to extend not over $\frac{5}{16}$ in. nor less than $\frac{3}{16}$ in. above the surface of the steel plate. The field circumferential joints will also be countersunk. The plates for this pipe shall meet the requirements of "Standard Specifications for Boiler and Firebox Steel for Locomotives, Flange Quality, Serial Designation A30-24," Am.Soc.T.M.

The button-head riveted steel pipe, in 30-ft. courses, shall be of the same specified quality of plates as mentioned in the preceding paragraph.

The foregoing statements as to plates all relate to those of 30-ft. lengths. For the plates from $7\frac{1}{2}$-ft. lengths, the same specifications for the plates govern as for the last two preceding paragraphs and the joints vary in requirement.

As stated at the beginning of this article, the Wanaque aqueduct has been the subject of controversy for several years past. This has related to the material to be used, whether it should be a single or twin conduit; if the latter, whether part or all of the way, and whether the aqueduct should be for gravity flow, except for inverted siphons, or under pressure for the entire distance, the latter hinging in turn upon whether or not there should be an aerator below the impounding reservoir, and, latterly, whether an aerator should be provided, but on the assumption that it would be used only a part of the year, the aqueduct taking the full head of the reservoir and the water when aerated being pumped to the aqueduct. Along with the controversy over material, pressure and aeration there have been several changes in the engineers directly responsible for design and construction.

In 1924 a gravity-flow aqueduct was recommended by Arthur H. Pratt, chief engineer, and Morris Sherrerd, consulting engineer. The recommendation was approved by the North Jersey District Water Supply Commission. The upper portion of this aqueduct was to be of concrete, except for inverted siphons of steel, and the lower part

also of steel. The concrete section would have been considerably less than half the total length of the aqueduct.

Plans and specifications for the recommended and adopted type of aqueduct appear to have been pretty well along toward completion when one of the four members of the North Jersey District Water Supply Commission was succeeded by a new appointee. Subsequently efforts were made by the commission to get the engineer and consulting engineer to advise a change to an all-steel aqueduct. This not being done by the engineers, after considerable delay the commission engaged George A. Johnson, New York City, to advise on whether the plan already adopted should be carried out or steel substituted as a material. This was in 1926. In 1927 Mr. Johnson advised radical changes in the plan, including twin steel pipes designated as "smooth-bore," abandonment of the aerator and use of the full head of the reservoir on the aqueduct. The commission adopted this plan, took the design and construction away from its engineer and consulting engineer (without discharging either) and put the work under Mr. Johnson.

Some of the contracting municipalities made inquiries as to the change and urged that a report on it be made by some other engineer, naming four, one of whom was tentatively agreed upon by the commission. This engineer being unable to serve, the commission waived aside the three others as objectionable for one reason or another and engaged a report from F. Herbert Snow, chief of the engineering division of the Pennsylvania Public Utilities Commission. About the same time that Mr. Snow submitted his report, which in general supported the Johnson plan, the commission voted to discontinue the services of Mr. Johnson.

The work then reverted to the charge of the engineer of the commission, who, with the co-operation of the consulting engineer, entered upon the preparation of plans and specifications for an all-steel aqueduct. Plans along these lines were so far completed early in 1928 as to be submitted to the contracting municipalities for consideration in connection with necessary supplementary contracts, owing to the need of additional money to complete the project, when three of the contracting municipalities—Paterson, Passaic and Clifton—engaged Fuller & McClintock, of New York City, to report on the need for an aerator. The engineers named reported to these municipalities that the aerator would be needed only for three months in the year and that it would be advisable to build an all-pressure aqueduct so as to utilize the full head of the reservoir, and to pump water from the aerator to the aqueduct when the aerator was in use.

The three municipalities just named requested the commission to make this change, urging, as pointed out by Fuller & McClintock and as also had been urged by Johnson, the advantages of having the full head of the reservoir. The commission voted in favor of the change and also, after solicitation of the three municipalities, put the entire engineering work of the aqueduct in the hands of Fuller & McClintock, again making no other change in the status of its engineer and consulting engineer. The doings mentioned in this paragraph occurred about the middle of the present year, although Fuller & McClintock were not officially engaged until later on.

Meanwhile another three of the contracting municipalities—Montclair, Bloomfield and Glen Ridge—engaged Metcalf & Eddy, of Boston, to advise them on the changes recommended by Fuller & McClintock. The report of Metcalf & Eddy has never been officially made public.

The commission, having been assured or virtually assured that all eight of the contracting municipalities would sign the necessary supplementary contract, decided recently to advertise for bids, but on the advice of Fuller & McClintock voted to permit bids on pipe made from plates rolled from 30-ft. lengths. Representatives of Newark insisted on including pipe from 7½-ft. plates, joined in the shop to make 30-ft. lengths. This change having been adopted by the commission, bids were invited for Dec. 20, on the specifications outlined in this article.

References to accounts of the controversy just outlined, with abstracts of several technical reports and also editorial comments, appearing in *Engineering News-Record* in the last two years, was given in these columns on Oct. 4, 1928, p. 523, but omitted references to July 5, 1928, p. 33, and Aug. 16, 1928, p. 258.

From Job and Office

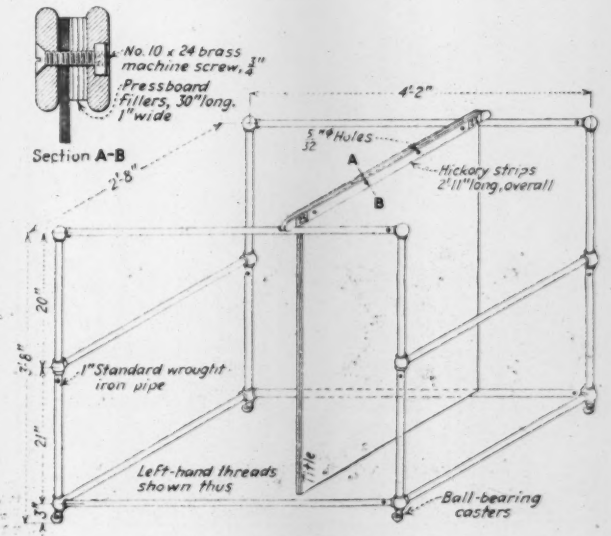
Hints That Cut Cost and Time for Contractor and Engineer

Keeping Blueprint Files Intact

By John H. Gregory

Consulting Engineer; Professor of Civil and Sanitary Engineering, Johns Hopkins University, Baltimore, Md.

In the *Engineering News-Record*, March 29, 1928, p. 523, is a brief description of a method worked out by Ross White on the project for the Feather River Power Company, California, for filing sets of blueprints vertically in a rack, the rack being attached to the wall, and in the issue of April 12, 1928, p. 509, Alfred B. Osborne states that the same method has been in use in the office of the Larkin Company, Inc., Buffalo, N. Y., for many years. These articles prompt the writer to call attention to a type of movable rack described in *Engineering Record*, Dec. 25, 1909, p. 712, and first used at Columbus, Ohio, in 1906, while the writer was in charge of the design and construction of the new water- and sewage-works there. It easily held some 2,000 blueprints then and is still in use.



MOVABLE RACK FOR BLUEPRINTS

In May, 1920, the writer had a similar rack made for holding drawings for the use of students in the civil engineering department of Johns Hopkins University, the rack alone costing about $20. At a little later date the geological department of the university had a rack made and at a still later date installed a fixed rack of the same type, 12 ft. long. This fixed rack will hold several thousand maps.

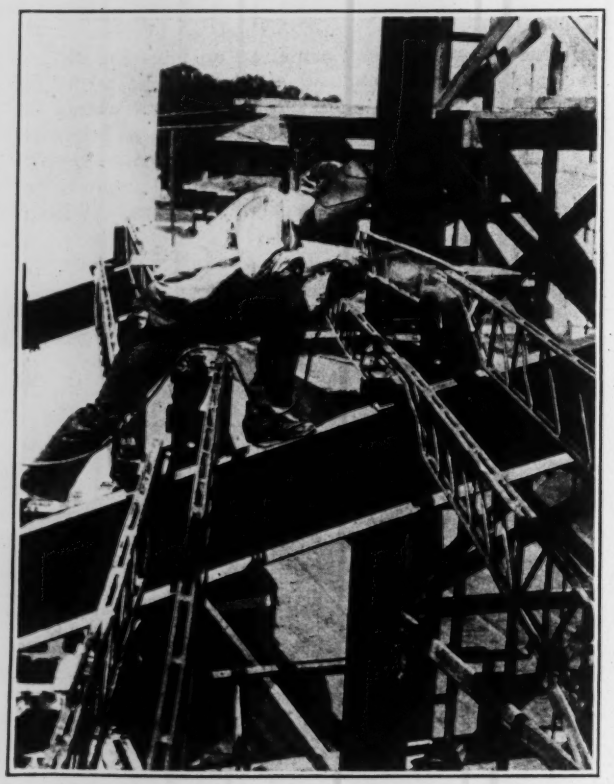
A movable rack is especially convenient, as it is often desirable to move drawings from one room to the other, and this may be easily done if the rack is mounted on large ball-bearing casters.

Erecting Bar Joists by Welding Proves Economical

By L. Douglas Moore
Edward S. Moore & Son, St. Petersburg, Fla.

AN ADAPTATION of arc welding in steel construction involving the erection of steel bar joists was economically made in the balcony floor framing for a new theater bulding in Tampa, Fla. In this building the bar joists supported a 3-in. floor slab and formed the face of successive risers. The metal lath for the floor was tied to and bent up the web of the joist and then laid horizontally to the next supporting joist. Because of these steps in the balcony, it was essential to fasten the joist securely to the structural members. Arc welding was decided upon as an experiment and proved to be so satisfactory that it was used throughout the job.

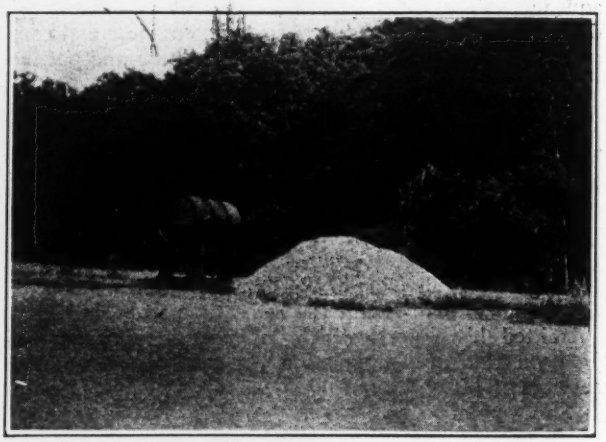
The welding outfit was a portable gasoline engine-driven generator delivering 150 amp. at 60 volts. The method proved to be surprisingly economical, with the entire cost of welding less than the cost of the standard accessories which would have been required. The saving effected therefore was equal to the estimated cost of attaching the joist clips. The welds were not tested in any accurate way to determine their value, but they could not be driven out of place by the blows of a sledge. It was apparent that the welds would hold more than required under any normal condition.



WELDING BAR JOISTS FOR BALCONY FRAMING

Patch Material for Bituminous Roads Placed Every 0.3 Mile

IN MAINTAINING its bituminous-type highways the Virginia State Highway Department stores convenient supplies of patching materials at intervals of about 0.3 mile along the roadside. These materials consist of 50-gal. tanks of bitumen placed on racks and piles of chips, gravel or sand, all located so that the haul from material supply to patch is never more than 1,000 ft. With material so readily available, it is believed there is no excuse for allowing a break to develop into a large hole. The tanks are never removed from the rack and are refilled by a hose connection from the surface-treating distributor. The cold patch is received in tank cars and the refilling is done in the early spring and late fall, when the distributor is not being used for other purposes. A good grade of lubricating oil drum proves very satisfactory for storage purposes. The drums and racks are painted once a year with cold bituminous pitch and kerosene in equal proportions. This keeps them glossy and makes their appearance at the roadside not objectionable.



SUPPLY STATION FOR BITUMINOUS PATCH MATERIAL

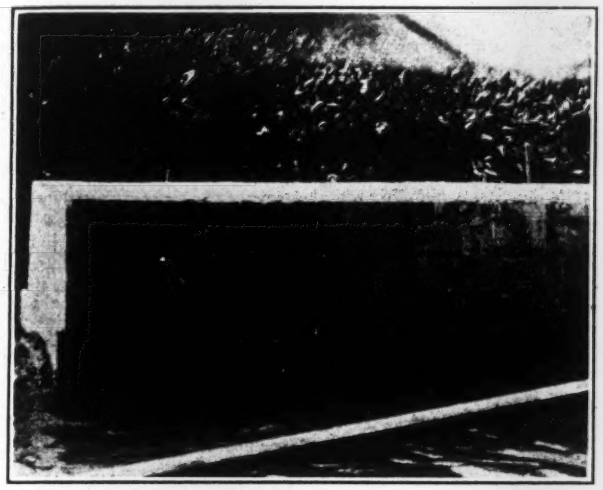
Experience With Various Type Sea Walls in Park Development

IN DEVELOPING the Anacostia River valley in the District of Columbia from marsh land and winding stream to a reclaimed park with restricted channel and an artificial lake, the United States Engineer Office, in Washington, D. C., has built a number of low sea walls. Several types of wall have been built and the experience with them is outlined below by E. J. Merrick, Jr., associate engineer.

"These sea walls are built as a finish to the park rather than to withstand seaway. The average rise of the tide is 3 ft. and the water is fresh but slightly polluted with sewage and gas tar refuse. Various types of sea walls have been used during the last twenty years in this locality. Originally the wall was laid up dry of well-bedded and coursed Potomac building stone quarried

within about 3 miles of the job. This same type of wall was later built with mortar joints. In both cases it was 6 ft. high, 2½ ft. to 3 ft. wide on top, with the back vertical and the front having a batter of 12 in. The bottom was set at mean low water. This wall was durable and presented a good appearance, but rising labor costs made it too expensive.

"The next type tried consisted of precast concrete blocks laid from mean low water to high tide and coursed building stone from high tide to the top. This type wall was fairly economical in construction, but the concrete blocks deteriorated rapidly due either to poor concrete or to a combination of chemical and mechanical action on the blocks between high and low water. About 1918 a concrete wall faced with building stone was built.



LOW SEAWALL WITH TILE LINER PLATE AS FACING

This was constructed by erecting a 3-ft. lift of building stone and pouring the main body of the wall of concrete behind it. This wall gave a distinct saving in cost and has proved durable, but the high labor cost of masons and continued high cost of building stone has caused us to experiment on other types in one of which tile liner plates are used for a facing on a concrete wall.

"The method of constructing the latter type of wall has been to set up a front-face form to which the tile are wired, and to pour concrete between this and a solid back form. This type of wall secured a wearing surface for the concrete between high and low water at a reasonable cost. It eliminated all work of masons, since the laborers could place the tile, and permitted the use of concrete for practically the entire volume of the wall. The interlock of the plates to the concrete was investigated by breaking off some of them and this interlock is apparently good. Further use of this type of wall is as yet undetermined, and further efforts are being made to secure a durable wall of straight concrete, which, of course, is cheapest."

St. Louis Adopts Photography for Recording Deeds

PHOTOGRAPHIC equipment has recently been placed in the office of the recorder of deeds in the city of St. Louis, and photographic methods will gradually replace the older methods of copying by hand and typing. According to the St. Louis Bureau of Municipal Research, other cities and counties which have used the photostat method report savings of 40 to 55 per cent over the older methods. During the first three months of operation of the photostat equipment, the average cost of recording in St. Louis was 32 per cent less than the average cost by the former method. The cost of copying by hand and typewriter during the fiscal year of 1926-27 was $0.0923 per folio of 100 words while the cost by the photostat method was $0.0630 per folio. It is stated that this reduction in cost was obtained with inexperienced help and with the equipment operating at less than one-half its capacity. Of the advantages claimed for the photographic records, the following are typical: Forged documents may easily be detected; fraudulent alteration of the records can readily be detected; errors in copying are reduced to a minimum; legible and uniform records are produced; and better service and increased economy are possible.

Letters to the Editor

Discussion by Readers of Various Matters That Interest Them

Supporting Capacities of Piles

Sir—In your Nov. 8 issue there are two strikingly contrasting views of the supporting capacities of piles.

In the article on the bridge across San Francisco Bay it is stated that "the concrete piles which were going down at the rate of ½ in. per blow when driving stopped were found to support 100 tons without appreciable settlement," and presumably the blow was that of 5,000 lb. with a 36-in. drop as mentioned later in the same article.

In the same issue in an article on the splicing of concrete piles the following quotation is from p. 703: "A test of 10-ft. drops of the hammer produced a penetration of ½ in., or 0.05 in. per blow, indicating a safe carrying capacity, so far as bearing was concerned, of about 38 tons." The hammer in this case was 4,000 lb.

E. OWEN WILLIAMS.

Westminster, England,
Nov. 26, 1928.

Well Points for Lowering Groundwater

Sir—With reference to Francis H. Kingsbury's letter in your issue of Oct. 11, 1928, pp. 560 and 561, on the subject of the well-point system for lowering the groundwater level, it may interest your readers that the earliest records of the use of this system go as far back as 1870, when, according to an article by F. C. J. van den Steen van Ommeren in the Dutch weekly *De Ingenieur*, 1903, p. 289, it was used for unwatering the excavation for a theater in Oldenburg, Germany.

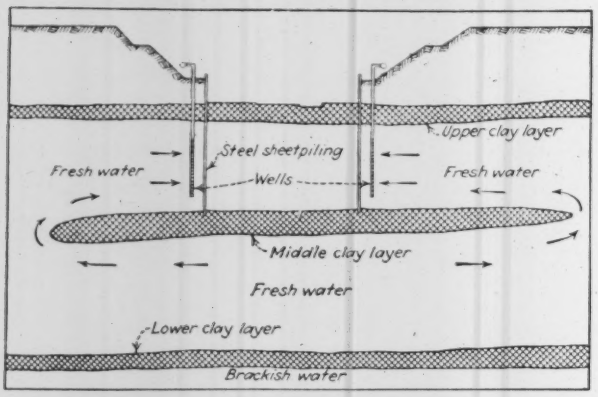
Mention of it is also made by Seyffert (*Zentralblatt der Bauverwaltung*, 1898, p. 199), who states that the system found application in 1886 with the construction of a deep central shaft for the water-works at Leipsic, Germany. In later years it seems to have been used in several other cases, especially by water-works engineers.

The system has now come into general use in Holland and the northern parts of Germany for the unwatering of deep excavations, and, in fact, the construction of large hydraulic works such as locks, graving docks and bridge piers, which otherwise would have required the use of the compressed air method, has by now become well-nigh inconceivable without the use of wells.

The system has accordingly been much developed practically as well as theoretically, and geological investigations and pumping trials where the hydrological methods common in water-works practice find useful application generally pre-

cede the taking in hand of the works. As a recent example, to which special interest attaches, I might cite the construction of the new entrance lock to the North Sea Canal at Ymuiden (Amsterdam harbor), which is now nearing completion.

Borings at the site of this lock, which, with a length of 1,315 ft., a clear passage of 164 ft. and a depth on the sill of 50 ft. (with mean half tide, ordnance datum), is going to be the largest lock in the world, revealed the existence of layers of clay at 54, 120 and 300 ft. below ordnance datum,



SECTION THROUGH SITE OF NORTH SEA CANAL LOCK
Diagram showing position of well points used in unwatering the excavation for the new lock at Ymuiden, Holland.

intersticed between strata of holocene and pleistocene sands (see sketch).

Advantage was taken of this situation by surrounding the lock heads with a wall of steel sheet piling of the exceptional length of 85 ft., reaching down well into the middle clay layer, and by reducing the hydrostatic pressure underneath the layer at 54 ft. below ordnance datum by means of a series of wells outside the steel wall, reaching to a depth of 112 ft. below ordnance datum.

With the further aid of another system of wells above the latter layer of clay, for the purpose of draining the upper sand layers, a perfectly dry excavation was obtained at a depth of some 60 ft. below the level of the North Sea Canal.

As a special feature it may finally be noted that, owing to the scarcity of fresh water in this densely populated part of Holland, the water pumped from the deep wells, which was perfectly fresh, was not wasted, but was delivered to a neighboring water-works pumping station and distributed, after having undergone the necessary treatment.

F. A. LIEFRINCK,
Engineer, Government Bureau for Water Supply.

The Hague,
Nov. 6, 1928.

Brown Coal Resources of Victoria

Sir—A paragraph in your issue of Sept. 6, 1928, under the heading "European Briefs," if allowed to go uncorrected, will create a wrong impression regarding the development of the brown coal resources of Victoria, in regard to both the initiation of that enterprise and the actual work that has been done. The open-cut brown coal mines at Yallourn, Victoria, are already highly developed. They were first operated by the State Electricity Commission of Victoria in April, 1924, and to date have produced 5,000,000 tons for the generation of electricity and the manufacture of briquets. During the year ended June 30 last the daily output of electricity from the Yallourn power house approximated 1,000,000 kw.-hr. and the production of briquets for the year was about 120,000 tons.

All the coal has been won by methods designed by Australian engineers, including the use of power shovels for the removal of overburden and the excavation of the coal, of cable-hauled trucks for the delivery of the coal and of steam trains for the transport of the overburden to the point of disposal.

The Yallourn field forms the base of Victoria's national scheme of electricity supply, with a transmission system which already embraces about 1,500 route miles of high-tension lines, radiating in all directions and giving service to many remote areas. It is probable that Victoria has more miles of high-tension lines per capita than any other country in the world. It is fairly certain that nowhere do transmission lines stretch for such long distances over sparsely settled areas. Every year these lines are extended farther into country districts, and the reticulation of the whole state with electricity produced for the most part at the Yallourn power station is coming into view.

Preparations are now being made to increase the output of briquets to 360,000 tons a year and to install a further 75,000 kw. of generating plant at the Yallourn power station. The enlarged briquetting factory and power station will be in operation in 1931, when 10,000 tons of coal will be required each day. The present daily output is 6,000 tons. The extensions of the power station will take care of the estimated electrical requirements of the state up to and including 1935, when further extensions of plant will probably be necessary.

The possibilities in briquet manufacture are by no means exhausted by the preparations being made for trebling the output, as about 2,000,000 tons per annum would be required to render the state independent of outside sources of fuel supply. However, the brown coal resources are unlimited, and Yallourn itself could supply 50,000 tons daily for 400 years.

The immense developmental work of the commission having thoroughly demonstrated the commercial value of the state's unlimited brown coal resources, the only question to be determined was whether or not the methods employed in coal winning were the best and most economical, especially in view of the greatly increased outputs which would be required in the future.

The only other open-cut brown coal fields in the world are in Germany. In that country long experience and patient research have resulted in the perfection of methods of open-cut coal winning, both for the generation of electricity and for the manufacture of briquets. The low-grade high-moisture brown coal is thereby enabled to compete successfully with rich black coal fields, which, unfortunately, Victoria does not possess. On the other hand, the Yallourn brown coal field, in regard to both the extent of the deposit and the ease with which the coal may be won, far surpasses some of the German fields which are being so successfully operated.

Before embarking upon any further development of the Yallourn field, therefore, the commission dispatched agents to Germany to study and report on the methods employed there. It also secured a visit from Herr J. Klitzing, director of the Bergbau A. G., one of the largest brown coal undertakings in the world. This gentleman submitted a valuable report, comprehending every detail of the work at Yallourn and offering a complete program for the reorganization of coal-winning operations, in accordance with the methods which had been found so successful in large-scale operations in Germany. Fortified by this report and by the observations of its own officials, the commission decided to model future operations at Yallourn on German lines, and the scheme which is now in process of being carried out involves the replacement of the power shovels by dredges, and the rope haulages and steam traction by electric transportation. Already a dredge is at work removing overburden, and next year a coal dredge will be installed in the open cut itself. The electrification of the transport system is also well advanced; one of its principal features will be an inclined steep haulage, with a grade of 1 in 6, for delivering the coal from the open cut.

It is expected that the cost of coal winning, which is now about 2s. 3d. per ton, will be reduced by the new methods to 1s. 9d. per ton. The remodeling of the works is proceeding very smoothly, each step taken forming part of the complete scheme and involving no interference with normal operations.

German firms made the only bids for the dredges, regarding which the specifications provide for supply and erection, hence the departure of German engineers for Australia at intervals.

R. LIDDELOW,
Commercial Manager and Secretary,
State Electricity Commission of Victoria.

Melbourne, Australia,
Oct. 23, 1928.

News of the Week

Jadwin Report Details Past Work and Future Plans of Engineers

Advises Spending $86,444,880 During Coming Fiscal Year for Rivers, Harbors and Flood Control

DETAILS of the expenditure of federal funds totaling $70,197,018.13, in addition to contributions from states, municipalities and private parties amounting to $2,844,803.36, are given in full in the annual report of the Chief of Engineers for the fiscal year ended June 30, 1928, recently made public. The number of works under the control of the Engineer Corps at the beginning of this period is given as 200 harbors, 292 rivers and 49 canals and other waterways. Besides this review of the past year's activities, a closely itemized list of amounts "that can be profitably expended during the fiscal year ending June 30, 1930" is given, totaling $86,444,880. The amounts are subdivided into general classes as follows:

	Fiscal Year Ending June 30, 1928	Fiscal Year Ending June 30, 1930
General river and harbor work	$50,207,532.96	$50,781,880
Flood Control:		
Under Mississippi River Commission	13,042,638.38	30,000,000
Under California Debris Commission	437,566.18	5,388,000
Other classifications	6,509,280.61	275,000
Total	$70,197,018.13	$86,444,880

For the current fiscal year, which ends June 30, 1929, Congress has already provided a sum of $55,886,310 for the work of the corps.

Recommended expenditures for the future are carefully itemized according to the needs of each of the many projects. Among the new projects listed (as distinguished from the maintenance of existing works) the outstanding in respect to expenditures involved and engineering interest are given in the following table:

New York harbor and vicinity, including Newark, N. J.	$3,217,400
Hudson River near Albany	1,200,000
Delaware River below Philadelphia	1,300,000
Inland waterway—Norfolk, Va. to Cape Fear River	1,385,000
Intra coastal waterway — New Orleans to Corpus Christi, Tex.	1,850,000
Mississippi River — Minneapolis to the Ohio River	5,580,000
Missouri River — Sioux City, Iowa, to the Mississippi	5,015,000
Monongahela, Allegheny and Ohio rivers	2,190,000
St. Marys River, Mich	2,050,000

Viaduct Completed at Albany

The Normanskill viaduct, near Albany, N. Y., has been completed at a cost of $284,822. The structure is 1,064 ft. long with a 30-ft. roadway and two 5-ft. sidewalks.

Electrify Cleveland Terminal

Beginning Jan. 1, 1929, all New York Central passenger trains in and out of Cleveland, Ohio, will be handled by electric locomotives throughout a sixteen mile zone extending from Linndale on the west, through the new terminal station to Collinwood on the east. A portion of this zone is on the right of way of the New York Central and Big Four, and the remainder on the Nickel Plate. Current distribution will be through overhead catenary construction at 3,000 volts direct current. The locomotives to be used will be of the geared type, weighing 204 tons and have six driving motors developing a total of 2,465 hp. continuous rating.

Engineers From Many Countries to Be at Engineering Congress

A representative number of engineers from all the major countries of Europe and from America have signified their intention of attending the World Engineering Congress to be held in Japan next year, according to Dr. Masawo Kamo, chairman of the organizing committee of the congress in a speech at a dinner in his honor held in the Engineers Club at New York Dec. 6. The congress is to be held in Tokyo from Oct. 25 to Nov. 20 and will include in its program a number of technical sessions on various phases of engineering, to be followed by trips to all the major engineering works in Japan and to large engineering works in Korea and Formosa. In order to facilitate travel, delegates and their wives are to be furnished with free transportation on all railways in Japan by the Japanese government and in South Manchuria by the South Manchuria Railway Company.

High Wind Causes New Breaks in Okeechobee Dikes

Several fresh breaks occurred in the dikes at South Bay on Lake Okeechobee, Fla., recently under the action of water driven by a high wind. The resulting floods in adjacent lands halted repair operations on dikes and buildings which were seriously damaged last September during the hurricane. The Everglades Drainage District, admitting that it is unable to finance control measures, has called on Congress to assume control.

Asphalt Road Experts Gather 500 Strong for New Orleans Congress

Delegates Discuss Construction, Maintenance and Research at Four-Day Meeting

A RECORD gathering of members of the Asphalt Association and the Association of Asphalt Paving Technologists met at New Orleans, La., last week for the seventh annual paving conference to be held under their auspices. Some 500 delegates from all sections of the country took part in the five working sessions. Australia, Denmark, Canada and other foreign countries were represented. Altogether the conference called together the largest number of men interested in asphalt roads that probably has ever before gathered in convention.

In opening the meeting President J. S. Helm centered his remarks on waste in roadbuilding. The annual waste on highways, Mr. Helm said, approximates $400,000,000. A principal cause is a tendency to dig up macadam or gravel roads before laying pavement. Builders should use the time-hammered road for a foundation, he said. A brief statement by President L. M. Law introduced the work of the technologists' section of the conference, and then the conference was welcomed on behalf of the Governor of Louisiana by John P. Sullivan, who spoke of the $30,000,000 bond issue road improvement program being inaugurated by the state. J. M. Fourmy, state highway engineer, then outlined the growth of the state highway system and stated that the bond issue money would go largely into paving main roads.

Technical discussions on the economics of asphalt paving were led by T. Warren Allen, chief of the division of management, United States Bureau of Public Roads, and M. H. Ulman, assistant engineer of materials for the Pennsylvania Highway Department. Charles Draney, superintendent of the municipal asphalt plant at Denver, Colo., also spoke.

Harry H. Blee, chief of the airport section, office of aeronautics, United State Department of Commerce, delivered an address on the airplane in American commerce and industry at the evening session. He outlined the government aid being extended air development just as it has been offered marine expansion. He spoke of the mounting importance and growth of commercial aviation and phrophesied that it would play a large part in the country's development.

"There are already approximately 1,000 airports under construction in the

United States," he said, "and 1,000 more are contemplated. There are 18,000 miles of airways over which scheduled national routes are operated. Of this 7,500 miles of the way are lighted."

A. H. Blanchard, Toledo, spoke on asphalt construction and treatment for airport runways. Soil investigation and subgrade treatments were discussed by F. H. Eno, Ohio State University. Chris P. Jenson, Fresno, Calif., told of black base pavement, and Harry J. Kirk presented the requirements for asphalt filler for brick pavements.

The reading of seven technical papers concerning service results from the use of asphalt in state and provincial highway construction occupied the third session. James M. Fourmy of Louisiana, V. R. Burton of Michigan, W. R. Neel of Georgia, V. L. Ostrander of Massachusetts, R. M. Smith of Ontario, John D. Waldrop of North Carolina and T. C. McEwen of Tennessee outlined to members of the association results of road-servicing experiments and practice in their respective communities.

The fourth session was devoted to committee reports and papers on technical subjects. Victor H. Roehrich, director of the bureau of testing laboratories, department of public utilities, St. Paul, Minn., discussed new principles applied to an improved method of extracting bitumens from paving mixtures. W. C. West, president of the West Process Pavement Company, of Louisville, Ky., read a paper on laboratory tests of roller work in paving. Use of the stability test in controlling uniformity of asphalt paving plant output was treated by Prevost Hubbard and F. C. Field, chemical engineers with the asphalt association.

Abstracts of these and other papers will be published next week.

New Natural Gas Field Opened in Canada

Location of a new natural gas field about 22 miles south of Lloydminster, Sask., has resulted from drilling carried on for oil following the publication of a report on the structure of that section by Dr. G. S. Hume, dominion government geologist. The first well to be drilled struck gas Oct. 30, and is now blowing off at an estimated rate of 30,000,000 cu.ft. daily. The well is located in what is known as the Ribstone Creek field, about 4 miles from the Alberta boundary.

Civil Service Positions Open

Positions in the government service now open to civil engineers include the following: Associate irrigation engineer, $3,200 to $3,700; assistant irrigation engineer, $2,600 to $3,100; chief engineering inspector-superintendent, $2,600 to $3,100; senior engineering inspector-foreman, $2,000 to $2,500; junior engineer and deck officer, $2,000; and junior engineer, $2,000. Applications for these posts will be received by the Civil Service Commission at Washington, D. C.

Missouri Airport Bonds Upheld

The Missouri Supreme Court Dec. 7 upheld the legality of the $2,000,000 St. Louis, Mo., airport bond issue voted last August, thereby removing the last legal barrier preventing the city from the immediate development of the Lambert-St. Louis flying field at Bridgeton, St. Louis County. The decision also affects the $1,000,000 airport approved by the Kansas City, Mo., voters.

The court had previously ruled the bond issues invalid on the ground that the law requiring a revision of the registration books had not been complied with. Subsequently, counsel for the municipality discovered a conflict in the law which has now been interpreted by the high court to bring the bond issue vote under the general election registration for the year in which it was voted.

Pittsburgh Completes Task of Raising Allegheny Bridge

Dedication of the new $1,650,000 31st St. bridge across the Allegheny River at Pittsburgh, Pa., Dec. 1 marked the end of the bridge-raising program initiated by order of the Secretary of War March 23, 1917, which affected seven spans across the Allegheny. Six of these were owned by Allegheny County, all of which now comply with the revised clearances required for navigation. The other structures effected were the Sixth, Seventh, Ninth, Sixteenth and 42d St. bridges.

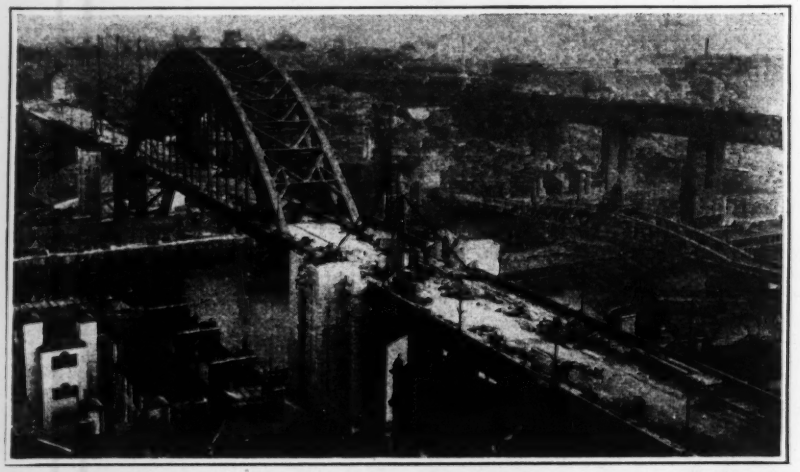
New Pipe Line Will Connect Oklahoma With Chicago

Formation of the Texas-Empire Pipe Line Company by the Texas Oil Corporation and the Empire Gas & Fuel Company is the first step in the construction of a $15,000,000 pipe line which will connect Oklahoma with Chicago. This line will be 636 miles long, of 12¾-in. pipe weighing approximately 40 lb. per foot, a total of about 72,000 tons. Contract for all pipe required for this line has been awarded to the A. O. Smith Corporation of Milwaukee, Wisconsin.

San Francisco-Oakland Bridge May Be a State Project

A plan whereby the State of California would build the proposed Bay bridge between San Francisco and Oakland has advanced to the stage in which officials of the state and of the city of San Francisco are agreed as to a method of procedure to be followed in placing the plan before Congress and before the California legislature. At a meeting of interested officials in San Francisco on Nov. 19, Governor Young of California voiced opposition of the state to privately owned toll bridges and highways. It was agreed at this meeting that Congress should be asked to grant a permit for the construction of this bridge by the California State Highway Commission, with the understanding that the project would be financed by the revenue bond method. On this basis the structure itself would be security for the

NOTABLE ENGLISH ARCH BRIDGE COMPLETED



This photograph was taken as final touches were being put on the Newcastle-Gatehead bridge over the River Tyne in England, which was opened by King George and Queen Mary recently. The two-hinged steel arch has a span of 531 ft. and a rise of 170 ft. The 38-ft. roadway has a clearance of 84 ft. above mean high water. Erection of the arch, which was tied back by steel cables until closure, was fully described in *Engineering News-Record*, July 5, 1928, p. 28. The approach spans, of plate girders 11 ft. 6 in. deep, were fastened together at the shore end of the bridge and pulled into place by means of cables. They were supported by octagonal steel columns with a maximum height of 70 ft., carrying rollers at the top to facilitate movement of the girders. Steel was furnished and erected by Dorman Long & Company, Middlesbrough, England. The cost of the bridge was approximately $6,000,000; 2,400 tons of steel was used in the arch, 1,600 in the decks and about 4,000 tons in the approach span.

bonds and the state would participate in the transaction only in a supervisory way.

An amendment to the California state law would be necessary to permit the state to take over this work on the revenue bond method, and a committee of six was named by the conference to draft the necessary legislation. Favorable action on the matter in the California legislature is expected to improve materially the prospect of favorable action by Congress.

Will Store Gas in Old Wells

Plans to conserve large surpluses of natural gas at present going to waste in the Turner Valley oil field southwest of Calgary, Alberta, were recently outlined by C. J. Yorath, president of the Canadian Western Natural Gas, Heat, Light & Power Company, in an address before the Engineering Institute of Canada. The company is planning to pipe gas from the Turner Valley field to the Bow Island field, now a depleted source of supply, and store it in the wells in that area. These plans involve relaying much of the pipe line from Turner Valley. The company feels that the result would be the storage at Bow Island of four or five times the present estimated content there of six or seven billion cubic feet of gas. Storage would be accomplished at odd periods during the summer months. The accumulated gas would serve to insure Calgary's supply in an emergency.

Consider Construction of Bridge Material Test Laboratory

Due to the large amount of testing necessary during the construction of the Hudson River and Kill van Kull bridges, the Port of New York Authority is considering the construction of a modern laboratory building to house testing machinery of latest approved design for testing all materials used in the bridges, ranging from gravel for concrete to steel girders and wire cables. Bids were opened December 3 for the proposed building, which would be of concrete, with concrete floors supported on steel beams. Alternative proposals were considered on a two-story and a four-story structure, although one portion of the building will, of necessity, be four stories in height to accommodate a large steel-testing machine. The low bid for a four-story building, submitted by the D'Elia Contracting Company, was $184,900; high bid was $247,700. On the two-story plan (including a partial four-story height) the D'Elia company again submitted the low bid of $135,975. The high bid was $197,100. Ten proposals were received for each alternative. The building will be about 100 by 50 feet, and will be located at West Side Avenue and Fox Place, Jersey City. The Port Authority will decide later in the month which type of structure should be built, or whether any construction at all is justified.

E. J. Pearson, Head of New Haven Railroad, Dies

Edward Jones Pearson, president of the New York, New Haven & Hartford Railroad, died on Dec. 7 at Baltimore, Md., at the age of 65. Although he had already presented his resignation to take effect on Dec. 31, his death was unexpected. Mr. Pearson was born in Rockville, Ind., and was graduated from

Underwood & Underwood

EDWARD J. PEARSON

Cornell University in 1883. Prior to this he had already worked as a rodman for the Missouri-Pacific Railroad. Upon graduation he entered the service of the Northern Pacific as an assistant engineer on construction work, and, in 1885, was appointed supervisor of bridges, buildings and water supplies of the Minnesota division of that road. He became principal assistant engineer of the Chicago & Northern Pacific and the Wisconsin Central lines in 1892, and chief engineer of the Northern Pacific in 1904. In 1911 Mr. Pearson was elected first vice-president of the Missouri Pacific, and in 1915 he became first vice-president of the Texas & Pacific Railway. From this company he came to the New Haven system in 1916 as vice-president in charge of engineering construction and operation and was elected to the presidency after the retirement of Howard Elliott in 1917. During federal operation of the railroad he was manager for the government of the New Haven system. He was a member of the American Society of Civil Engineers and the American Railway Engineering Association.

Ottawa to Have Filtration Plant

Approval by the taxpayers of Ottawa, Canada, of a $1,315,000 bylaw provides for the construction of a rapid sand-filtration plant at Lemieux Island, on the Ottawa River. The engineering department of the city will proceed immediately with the necessary laboratory and research work in order that construction may be commenced without delay.

Brief News

BITUMINOUS MATERIALS AND PAVEMENTS will be the subject of a short course to be given at the University of Michigan, Ann Arbor, during the Christmas vacation. Work will start Dec. 26 and end Jan. 5. There are no prerequisites to the course, and anyone interested in the subject will be admitted.

NATURAL GAS will be conducted from Clarksville to Little Rock, Ark., through a 105-mile welded pipe line now being completed by Booth & Flinn, Pittsburgh, Pa. Construction was started Sept. 12.

FOURTEEN NEW BRANCH LINES, totaling 330 miles, have been built by the Canadian Pacific Railway during the past summer in western Canada.

NO BIDS WERE RECEIVED by the Kentucky State Highway Department on a recent offering of $25,000,000 in bridge bonds, although two financial houses submitted offers on different terms than were laid down by the commission. Both of these were rejected, and it is understood that a new call for bids will soon be issued.

PLANS FOR A VEHICULAR BRIDGE connecting the island of Montreal with the south shore of the St. Lawrence River have been completed by the Department of Public Works of Quebec, and it is expected that work will be under way early in 1929. The structure will be about 3,000 ft. long and will cost approximately $1,800,000.

TERMINAL WAREHOUSE IMPROVEMENTS in Montreal involving an expenditure of $2,000,000 are planned by the National Terminals of Canada, Ltd. This company has leased, with option to purchase, the business of the Terminal Warehousing Company, Ltd., under a contract which provides for immediate improvement.

State Dam Supervision Debated at San Francisco

At the call of the director of the California Department of Public Works and the State Railroad Commission, a hearing was held in San Francisco, Dec. 7 and 8, to allow those interested to discuss proposed legislation covering state regulation and supervision of dams. About thirty persons attended, including the state engineer, consulting engineers, engineers of the Railroad Commission, representatives of numerous power companies and members of a committee representing the four California sections of the American Society of Civil Engineers, which has been preparing a bill to be submitted to the next state legislature.

Sessions on both days were replete with discussion. Various proposals were put to a vote. Among those approved were: (1) that some new legislation is necessary relative to state regu-

lation and supervision over dams; (2) that authority for the needed control should be vested in a single officer of the state; (3) excepting only dams built by the federal government, all dams within the state should be subject to state control provided the height exceeds 10 ft. or the storage exceeds 10 acre-ft. or the drainage basin exceeds one square mile in area. It was also agreed that dams now in service should be inspected and checked up by the same state authority in which is vested control over construction of new dams.

The bill as prepared by the committee representing sections of the American Society of Civil Engineers, which was presented and filed for further consideration, suggested a complete program for state control with penalties for violation. This bill would vest authority for granting permits in the office of the director of public works, and responsibility for checking, inspection and supervision in the office of the state engineer, who would, when conditions made it desirable, call in as aids a board of consulting engineers to be paid by the applicant.

Dallas Seeks Reduction in Freight Rates on Pipe

A number of Texas municipalities including Dallas, Fort Worth and San Antonio have applied to the Interstate Commerce Commission for a reduction in freight rates on cast-iron pipe. It is expected that a hearing will be held in the near future. Dallas has just decided to buy over 25,000 tons of cast-iron pipe which will be shipped from Birmingham, Ala., to that city. The present freight rate of $12 a ton is held to be excessive, and the Texas municipalities are contending that a reasonable rate should not exceed $10.80 a ton. Reduction to this figure would mean a saving of $30,000 in the freight cost on this amount of pipe, which would, through the terms of the contract, react in favor of the city.

To Design Pacific Coast Bridge

Robinson & Steinman, consulting engineers, of New York, will design and supervise the construction of the proposed St. John's bridge across the Willamette River in Portland, Ore., on a flat fee of $145,000, according to announcement from the office of the board of county commissioners Nov. 14. The fee covers all services in connection with the erection of the bridge and its approaches and is also to include any patents they may hold on any items of equipment needed for the erection of the bridge.

It has not been decided whether the St. John's bridge will be of the suspension or cantilever type, but conferences will be held with the county commissioners regarding this matter. At any rate this bridge will have the longest span of any on the Pacific Coast, according to Mr. Steinman.

WASHINGTON NOTES

By Paul Wooton
Washington Correspondent

Senate Debates Boulder Dam—No Action Likely on Public Works Bill—Reopen Hero Bridge Plan

EARLY passage by the Senate of an amended Boulder dam bill seems probable as this is written. Arizona and California appear to be at the point of reaching a compromise. The debate on the bill, which has occupied the attention of the Senate since the opening of Congress, has been confined largely to questions of the division of water. What some regard as the more important economic and engineering aspects of the question have come in for relatively little attention. The Senate, as a whole, is showing little interest in the discussion. The general expectation is that many Senators will vote for the measure if the states immediately concerned are willing to support the bill. There is certain to be a sharp clash on the amendments. Many difficulties will face the conference committee of the House. If the House will accept the provisions of the Senate bill, under which the Secretary of the Interior is allowed to use his discretion in the handling of the water power which may be developed, it is believed that the President will sign the bill. In view of his message to Congress it is taken for granted that he would veto the bill in the form that it passed the House. Under the Senate bill it is left to the Secretary of the Interior to determine whether the use of the water shall be leased, whether the government builds the power plant, or whether the government builds and operates the power plant.

Public Works Bill Delayed

No action is likely on the Wyant bill for co-ordination of the public works activities of the government under the Secretary of the Interior until the extra session, according to members of the House committee in charge of the bill. Representative Williamson, chairman of a subcommittee appointed to deal with the measure, is not even certain that he will be able to submit a favorable report to the full committee at this session.

Even were the bill reported favorably by the committee, Mr. Williamson believes that it would have little chance of passing the House at this session. He feels confident, however, that the Hoover administration will be kindly disposed toward this proposed consolidation of the government's engineering functions. In this connection Mr. Williamson calls attention to the fact that Mr. Hoover referred to the desirability of such executive consolidations in his acceptance speech.

It is understood that the supporters of the bill have agreed to exclude the Bureau of Public Roads and the office of the architect of the Capitol from the grouping of public works functions under the Secretary of the Interior. This compromise was effected, it is stated, to save the bill from certain defeat.

Budget Items

The budget submitted to Congress carries $179,500 for the Federal Power Commission. This is an increase of $52,800 over the present appropriation, when the 1928 salary increase is taken into account. The increase is intended largely for additional personnel. It is proposed to engage directly a law officer rather than call upon the departments for the detail of a man to act as the commission's chief counsel. The salary is $6,500. It also is planned to pay $5,600 for an attorney to handle valuation matters. An additional engineer to receive $4,600 is requested.

The budget also calls for $2,000,000 for the continuation of work on the Arlington memorial bridge during the next fiscal year. This is $300,000 less than was appropriated for the work this year. The difference is in the cost of the work to be done. There will be no reduction in the personnel of the staff, which is composed of 55 persons, including one engineer at $5,600, one engineer at $4,800, two inspectors at $3,400, one structural designer at $3,300 and four inspectors at $2,850.

Reconsider New Orleans Bridge

Consideration of a permit authorizing the construction of a bridge (the Hero project) over the Mississippi River within the harbor limits of New Orleans has been reopened by the Chief of Engineers. General Jadwin recently denied this application, but the demand for the structure by the city government and by the business interests has been so pronounced that the case was reopened and a formal hearing held Dec. 10. General Jadwin took the position that a bridge which would divide the harbor would relegate the portion above the bridge to a secondary position. Louisiana Senators and Congressmen, together with various witnesses representing local interests, argued that the natural development of the harbor is trending downstream and along the industrial canal. It was pointed out that ample area is available for indefinite development that way, although doubt was expressed that there would be any curtailment of the use of docks above a bridge with 135 ft. of clearance with no span in the channel. It is planned to suspend the bridge between large towers on each bank which would contain ramp systems to carry the vehicular traffic.

Cumberland Falls Hearing Held

Proponents of the development of the power resources at Cumberland Falls in Kentucky made an effective showing at the public hearing Dec. 5 before the Federal Power Commission and its staff. The hearing revealed

that the people in a wide region around the falls are unanimously in favor of the proposed hydro-electric development, which is combined with a park plan which meets their entire approval.

Speaking on behalf of the Middle West Utility Company, the Kentucky Utilities Company and the Cumberland Hydro-Electric Company (organized to carry through the project), R. H. Gordon, chief counsel, outlined the progress and scope of the development. After the applicant Cumberland Hydro-Electric Company had gained an option to the site in 1921 and a permit from the Federal Power Commission in 1924 to proceed with preliminaries, a total of about $350,000 was spent or obligated for surveys, plans and final acquisition of the property. Mr. Gordon stated that during this time no opposition was registered, although ample publicity was given. The plans call for a dam 80 ft. high and 800 ft. long 3,500 ft. above the falls, a 19-ft. diameter tunnel cutting off a horseshoe bend and supplying a power plant 4,800 ft. below the falls, and a small dam making a cushion pool below the spillway of the main structure. The point was made that the dam plant and appurtenant works cannot be seen from the falls and therefore do not mar the main scenic feature.

Engineering Societies

CALENDAR

Annual Meetings

AMERICAN ROAD BUILDERS' ASSOCIATION, Washington, D. C.; annual convention, Cleveland, Ohio, Jan. 14-18.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York, N. Y.; annual meeting, New York, N. Y., Jan. 16-18.

AMERICAN CONCRETE INSTITUTE, Detroit, Mich.; annual convention, Detroit, Mich., Feb. 12-14.

THE EASTERN SECTION, Seismological Society of America, has accepted the invitation of Fordham University to hold its 1929 meeting in New York City. The date will be decided later.

THE MONTREAL BRANCH, Engineering Institute of Canada, will hold its annual meeting Dec. 20.

THE NATIONAL BUILDERS SUPPLY ASSOCIATION, Cleveland, Ohio, and the SOUTHERN BUILDERS SUPPLY ASSOCIATION held a joint meeting Dec. 3-8 at Memphis, Tenn. This was the first joint meeting of the two associations, and resulted in a decision to consolidate. While the Southern association remains nominally the same, the National association will be its directing head. For the National association, the following were elected officers: W. W. Campbell, New Wilmington, Pa., president; John Suelzer, Jr., Fort Wayne, Ind., vice-president; Frank McKenna, New Jersey, secretary. The Southern association elected E. S. Spencer, of Jacksonville, Fla., president; Robert Hibbler, Chattanooga, Tenn., Frank D. Horton, Birmingham, Ala., and John E. Thayer, Asheville, N. C., vice-presidents; R. L. McChesney, New Orleans, La., secretary. In connection with the meeting there was an extensive exhibit.

THE ST. LOUIS SECTION, American Society of Civil Engineers, has elected the following officers: President, R. J. Lockwood; vice-presidents, W. C. E. Becker and F. W. Green; secretary-treasurer, H. A. Willis; counselors, C. M. Dailey and J. C. Pritchard.

THE ENGINEERING SOCIETY OF ROCHESTER, at a recent meeting, heard William S. Lozier, consulting engineer, speak on the subject of a master plan for the city and its suburban territory.

THE NEW YORK SECTION, American Water Works Association, will hold its next meeting Dec. 28. This will be a luncheon meeting.

THE BOSTON SOCIETY OF CIVIL ENGINEERS, Designers Section, heard L. B. Lent, engineer of the Common Brick Manufacturers Association, speak on the manufacture and use of brick at its meeting on Dec. 12.

THE BALTIMORE SECTION, American Society of Civil Engineers, held a meeting Dec. 6 at which Charles F. Goob, chief engineer of Baltimore, presented an illustrated paper on airports.

Personal Notes

Dr. J. A. L. WADDELL, consulting engineer, has been retained by the Chinese nationalist government to act as adviser to its department of railways. He will sail from San Francisco Jan. 4.

THOMAS D. HUNT has been appointed county engineer of Kings County, Wash., succeeding DON H. EVANS, who was recently elected county commissioner. Mr. Hunt has had eight years' experience in the county engineer's office, the last two as chief deputy. He is secretary of the Western Washington Section of the American Society of Civil Engineers.

WALTER COMBS, formerly assistant city engineer for Pine Bluff, Ark., has been named city engineer to succeed FRANK R. ALLEN, who resigned recently to enter the construction material and equipment business in Pine Bluff.

ALONZO J. HAMMOND, for the last two years chief engineer of the Mellon-Stuart Company, engineers and contractors, Chicago, has opened an office in that city for general engineering consulting practice.

WILLIAM W. TEFFT, who has been chief engineer of the Commonwealth Power Corporation for the last five years, has resigned to devote his entire time to his consulting engineering practice. He continues his residence and official headquarters in Jackson, Mich. Mr. Tefft is the inventor and owner of the Tefft conduit spillway and accelerator, which has been installed in several large hydro-electric developments during the last few years.

WALTER R. EGGLESTON, county superintendent of highways for Jefferson County, New York, whose term expires Dec. 31, 1928, has been reappointed for four years.

RALPH I. MEEKER has been engaged by the U. S. Engineer Office at Memphis, Tenn., to study and report on irrigation possibilities of the Arkansas River and its tributaries in connection with Mississippi flood control. Mr. Meeker is a special deputy of the Colorado State Engineering Department.

M. F. LONGWILL, assistant to the president of the Wabash Railway, has been appointed chief engineer to fill the vacancy caused by the death of R. H. Howard. Mr. Longwill entered the employ of the Wabash in 1918 as a division engineer, was promoted to assistant chief engineer in 1923, and in 1925 was made assistant to the president. He is 46 years old and a graduate of Ohio Northern University.

GEORGE F. WHEELER, who has been assistant to the chief engineer of Pan American Airways, Inc., and business manager of *New York Airways*, has been added to the staff of Black & Bigelow, Inc., air transport engineers, of New York.

WALTER W. SCHLECHT has been appointed resident engineer in charge of the design and construction of the Alhajuela project for the Panama Canal. Mr. Schlecht was formerly employed in Porto Rico and by the U. S. Reclamation Service on the design and construction of dams and hydro-electric plants. On his graduation from Columbia University he was employed by the Admiral Walker commission and now returns to the Isthmus after an absence of 28 years.

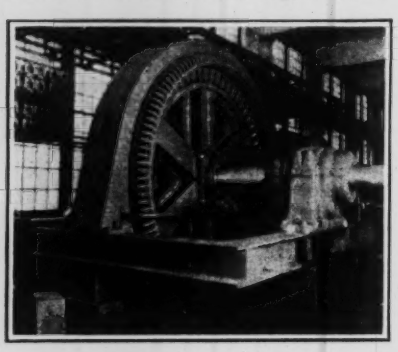
Obituary

EDWARD KIRK COE, formerly city engineer of Duluth, Minn., died on Nov. 16 in that city at the age of 60. A graduate of Cornell College, Mount Vernon, Iowa, Mr. Coe had been connected with the Duluth, Missabe & Northern, the Great Northern and the Duluth & Iron Range railroads, as well as the city of Duluth. During the war he was a major in the Engineer Corps, serving as constructing quartermaster at Camp Lee, Va., until October, 1917, when he was sent abroad at his own request. In France he served under the Director of Construction and Forestry. He was a member of the American Society of Civil Engineers and of the Society of American Military Engineers.

Construction Equipment and Materials

Welding in Machine Fabrication Makes Rapid Progress

Replacement of iron castings with welded structural steel members for heavy machine parts has made rapid advances during the past year, according to A. M. Candy, of the Westinghouse Electric & Manufacturing Company, Pittsburgh, Pa. The use of arc-welded plates, shapes and bar stock to produce a substitute for cast-iron units results in a number of advantages in the field of machinery design and construction, due to the inherent advantages of commercial rolled steel over cast iron and the advantages of the fabrication process over present-day foundry and pattern shop practices. In addition to the greater strength and elasticity of steel, the advantages are: Less weight, lower cost, simplified design, homogeneity of metal, earlier delivery and easy repair. The illustration shows a large 300-hp. synchronous motor built with arc-welded bed plates, frame and rotor. The only cast-iron parts in this machine are the two pedestal bearings.



Florida Organizing Road Show

The first road show and conference to be held in the Southeast is being planned for March 19-23, 1929, at Jacksonville, Fla., under the auspices of the Florida Road Builders' Association, the University of Florida engineering department and extension division, the State Road Department, the Florida Engineering Society, the Florida Paving Contractors' Association and the Jacksonville Chamber of Commerce. In connection with the machinery show there will be a conference planned to present many aspects of roadbuilding, including methods, material, traffic studies, design and maintenance. Permission has been secured from the Florida State Fair Association to use such buildings as may be necessary and its grounds, including an open-air demonstration field for heavy machinery.

While the project is officially known as the Florida Road Builders' Show and Conference, it is not the intention to limit either exhibitors or visitors to one state. Invitations to attend and participate will be extended to the state highway departments of the eight Southeastern states and also county commissioners, city commissioners and city and county engineers. It is pointed out that these eight states in 1927 spent more than $150,000,000 in highway construction and maintenance.

Organization of the show and conference is under the direction of the Florida Road Builders' Association, which was formed for this purpose. J. J. Hedrick, Jr., of Tampa, is president, and Ike Parrish is secretary and general manager. The office of the association is in Jacksonville.

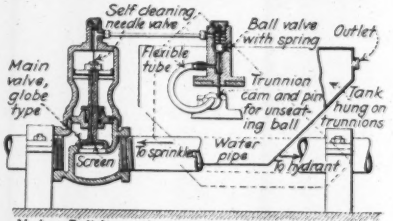
Foote Bros. Company Expands

Negotiations which have been under way for several months have resulted in the acquisition by the Foote Bros. Gear & Machine Company, Chicago, Ill., of an interest in four companies specializing in the manufacture of highway and roadbuilding equipment. These are: Lyle Culvert & Road Equipment Company, Stockland Road Machinery Company and Northwestern Steel & Iron Corporation, all of Minneapolis, Minn., and the Bates Manufacturing Company, of Joliet, Ill. The personnel and organization of all the new plants will be retained, while general and executive offices will be maintained at Chicago.

New Developments

Intermittent Sprinkler Operated by Automatic Valve

Curing of concrete pavement by occasional sprinkling without the necessity of manual operation is made possible by a new automatic sprinkler valve developed by E. L. Gaines, of the Seattle, Wash., City Planning Commission. This device has proved so successful that it is now being manufactured by the Eagle Brass Foundry Company, of Seattle. The action of the device is illustrated by the accompanying sketch. A main valve of the globe type is placed in the supply line, controlled by a single acting piston, the piston rod being identical with the valve stem and being hollow to admit water from the inlet side of the valve to the top of the cylinder. Above this is a stiff needle fixed above the piston and extending downward through a bushing into the piston rod, the closeness of the needle fit determining the flow of water and, consequently, the timing of the device. Water flows through the hollow piston rod into the cylinder chamber and thence through a small pipe to a ball valve, which is held open by a cam and hinge connected with a small closed tipple tank. This tank, with a capacity of about a quart, is counterweighted so so that it will remain in the position shown until practically full of water, when it becomes overbalanced and falls forward to the position shown by the dotted line. This change in position has the effect of closing the ball valve. Pressure is then built up in the cylinder of the main valve. Since the area of the valve piston is larger than the area of the valve itself, the flow of water through the main line is shut off.



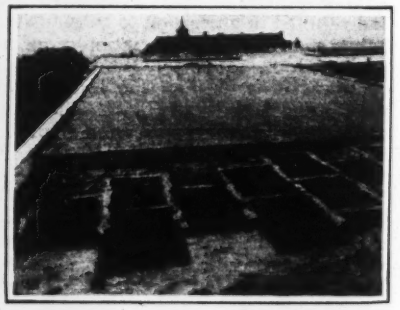
Note:-Full lines show position of tank when filling
Dash lines, position when discharging

The tank remains in the last position until all the water has leaked out through a small orifice at the right end, at which time the counterbalance acts to restore it to position, relieving the pressure in the main valve cylinder and opening the valve to permit flow to the sprinklers.

The entire mechanism, which is known as a Sprinkletimer, is inclosed in a strong cast-iron box 15 in. long, 11 in. high and about 7 in. wide, which may be closed and locked to prevent tampering. Although developed for use in curing concrete, this device is equally adaptable for other uses, such as lawn-sprinkling systems.

German Insulation Material Made of Peat Moss

Although used in Europe for the past twenty years, it is only recently that insulation material made of dried peat moss has been introduced into this country under the trade name of Torfoleum. This material is suitable both for heat and sound insulation, and is applicable to buildings, roofs, refrigerator cars and many other uses. It is impregnated against water absorption and is non-capillary. A 1-in. thickness of Torfoleum has conductivity



of 0.27 B.t.u. per square foot per hour per degree temperature difference, according to laboratory tests. In a 1-in. slab the pressure under a load of 1,764 lb. per sq.ft. is only 0.03 in. The material is made in sheets 19½ in. wide by 39 in. long and in thickness ranging from 1 to 6 in. The weight is less than 1 lb. per board foot. It contains no bituminous or mineral binder, and may be nailed or cut with a knife or saw. It may be used as a heat insulator up to a temperature of 230 deg. F. Torfoleum is marketed in this country by Pennrich & Company, 29 Broadway, New York City.

Protective Coating for Use on Galvanized Surfaces

Protection of galvanized metal and zinc products from weather or the effects of gas, acid, smoke or brine is the purpose of a liquid coating being marketed by Liquid Metal Products, Inc., Chicago, Ill. A natural base background for paint or paste is also obtained by its use. The liquid, when properly applied, unites with the galvanized surface, depositing a coating of protective material on the metal. This coating dries hard and will not peel from the surface. It may be applied with a brush or by dipping in a tank of the liquid.

Business Notes

UNIVERSAL CRANE COMPANY, Cleveland, Ohio, announces that I. C. Moller, of its organization, has been named an honorary vice-president of the National Highway Traffic Association.

CHAIN BELT COMPANY, Milwaukee, Wis., has appointed W. B. Marshall sales manager of its contract engineering department. Mr. Marshall has been with the Chain Belt Company since his graduation from Sheffield Scientific School, Yale University, in 1921.

CONTINENTAL MOTORS CORPORATION, Muskegon, Mich., has appointed Sid G. Harris sales representative in the East for the industrial division.

U. S. GYPSUM COMPANY is now distributing metal lath of all types and metal lath accessories through its regular distribution system. H. B. Spackman, formerly with the Northwestern Expanded Metal Company and the Milwaukee Corrugating Company, has been placed in charge of metal lath sales, with headquarters at Chicago.

UNIVERSAL PORTLAND CEMENT COMPANY, Chicago, Ill., has made a number of changes in its organization as follows: R. H. Hoy, former division sales manager, now sales manager, Pittsburgh; N. A. Kelly, former division sales manager, sales manager, New York; J. K. Hallock, former division sales manager, assistant sales manager, Pittsburgh; F. A. Brine, division sales manager, Pittsburgh, succeeding R. H. Hoy; W. H. McDowell, former sales agent, Cleveland, division sales manager, Pittsburgh.

BOSTON WOVEN HOSE & RUBBER COMPANY, Boston, Mass., has appointed Harrison J. Behr a special field representative. Mr. Behr was associated with the B. F. Goodrich Rubber Company, of Akron, Ohio, for more than twelve years, and has also had seven years experience with the U. S. Rubber Company, Cleveland, Ohio.

MILWAUKEE CORRUGATING COMPANY, Milwaukee, Wis., has purchased the Eller Manufacturing Company, Canton, Ohio. The two companies will become affiliated Jan. 1, 1929, with practically no changes in personnel.

PENNSYLVANIA-DIXIE CEMENT CORPORATION has appointed Walter S. Wing, for the past thirteen years Eastern sales manager of the Universal Portland Cement Company, to the post of general sales manager.

FEDERAL SEABOARD TERRA COTTA CORPORATION is the name of a new firm organized as the result of a merger including the New Jersey Terra Cotta Company, the Federal Terra Cotta Company and the South Amboy Terra Cotta Company. Executive and sales offices of the new concern will be maintained in New York City.

JEFFREY MANUFACTURING COMPANY, Columbus, Ohio, has placed Stanley M. Mercier in charge of its Boston office.

WAGNER ELECTRIC CORPORATION, St. Louis, Mo., has appointed Paul F. Forsyth branch manager of its Cincinnati, Ohio, office. Before coming with the Wagner corporation in 1915, Mr. Forsyth was with the J. G. White Company and the Detroit Edison Company.

TRACKSON COMPANY, Milwaukee, Wis., has added the following to its list of distributors: the Brinker Supply Company, Pittsburgh, Pa., and R. L. Stockard & Son, Nashville, Tenn.

GROSS METAL PRODUCTS COMPANY, Minneapolis, Minn., has appointed J. Wilson Wood, Raleigh, N. C., distributor for its products in the State of North Carolina.

Manufacturers and Trade Associations

CALENDAR

ANNUAL MEETINGS

NATIONAL SAND AND GRAVEL ASSOCIATION, Washington, D. C.; annual convention, Cleveland, Ohio, Jan. 9-11, 1929.

AMERICAN ROAD BUILDERS ASSOCIATION, Washington, D. C.; annual convention, Cleveland, Ohio, Jan. 14-18, 1929.

NATIONAL CRUSHED STONE ASSOCIATION, Washington, D. C.; annual convention, Cleveland, Ohio, Jan. 21-24, 1929.

New Publications

Explosives and Blasting Supplies—HERCULES POWDER COMPANY, INC., Wilmington, Del., has issued two new catalogs, one devoted to high explosives and blasting, the other to blasting supplies.

Centrifugal Pumps—ALDRIDGE PUMP COMPANY, Allentown, Pa., has put out the second edition of its centrifugal pump catalog, which not only gives detailed specifications of the pumps manufactured by the company but also contains a number of tables and formulas of value in designing pump installations.

Cranes and Trolleys—H. D. CONKEY & COMPANY, Mendota, Ill., has issued a new 47-p. illustrated catalog describing the Conco line of overhead equipment, including cranes, trolleys, current collectors and accessories for material handling.

Sheet Piling—JONES & LAUGHLIN STEEL CORPORATION, Pittsburgh, Pa., has issued Bulletin A, describing the first two of the proposed six new sections of J & L steel piling to be placed on the market. Bulletins relating to the four additional sections will be issued at a later date and will be followed by a complete catalog covering all sections.

Pavement — AMERICAN VIBROLITHIC CORPORATION, Des Moines, Iowa, has issued a revised edition of its catalog, describing the Vibrolithic process of paving. This illustrated book of twenty pages gives a step-by-step review of the Vibrolithic process and also a number of pictures of finished installations. It also contains a list of Vibrolithic pavements already installed.

Meters — CONNERSVILLE BLOWER COMPANY, Connersville, Ind., has revised its Bulletin 4-D, describing and illustrating Connersville meters. A brief history of the development of the double impeller type of blower or pump and of the rotary displacement meter is included.

Steel Buildings—BLAW KNOX COMPANY, Pittsburgh, Pa., describes a large number of standard buildings of galvanized copper bearing steel in a new bulletin, No. 1057.

Steel Windows and Doors—MACOMBER STEEL COMPANY, Canton, Ohio, has issued Catalog 612, which gives in extensive form designing data and erecting details for Massillon pivoted steel windows and stock-size steel doors.

Cornices, Marquises and Skylights—AMERICAN ROLLING MILL COMPANY, Middletown, Ohio, through the Armco architectural consulting service has issued a handbook on galvanized iron for cornices, marquises and skylights. This is a 60-p. book which gives details of roof construction with galvanized iron, as well as specifications, suggestions and tables and a discussion of the development and uses of pure iron.

The Business Side of Construction

Women Given Equal Recognition With Men in Industry

Women have practically equal opportunity of employment with men in manufacturing industries where they are capable of doing the same work as men and doing it as well, in the light of a study of the subject made by the National Industrial Conference Board. This conclusion is based on an analysis of reports of 129 manufacturing companies, 65 of which stated a preference for men, 47, however, preferring women, while seventeen expressed no preference.

Comparatively little objection was found to exist among manufacturers to the employment of married women. Out of a total of 22 companies employing women, only seven will not keep a woman worker after marriage and one company requires any woman employee who marries to resign within six months. Six establishments, while not following a rigid rule of discharging married women employees, follow a policy of discouraging them from remaining. On the other hand, fifteen companies encourage women workers to remain after they marry, while four companies out of the total number adapt their policy to the circumstances in each individual case. One company favors widowed women employees. The majority of industrial managers, however, evidently consider a woman worker's marital status as a pertinent or important factor in determining her desirability as an employee.

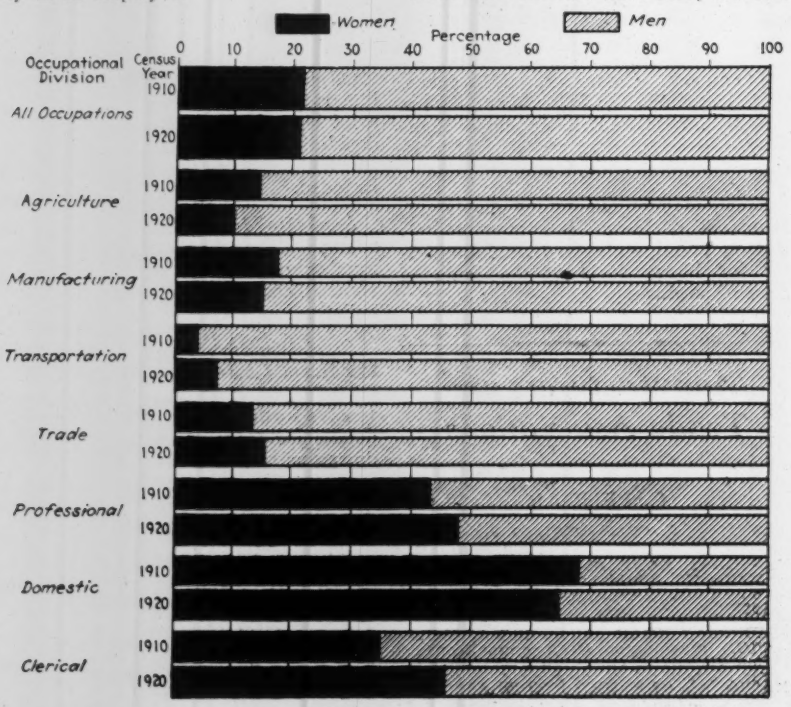
E. N.-R. Index Numbers

	Cost		Volume	
Dec. 1, 1928	**210.16**	**November, 1928**	**251**
Nov. 1, 1928	209.46	October, 1928	363
Dec. 1, 1927	203.90	November, 1927	272
Average, 1927	206.24	Average, 1927	263
Average, 1926	208.03	Average, 1926	228
1913	100.00	1913	100

But while the opportunity for employment in the manufacturing industries, where the work is of such nature as can be done equally well by either men or women, is practically the same for women as for men, less equality exists in the matter of wage earnings. Women's hourly earnings in the manufacturing industries range approximately 35 per cent lower than those of men. This, however, the Conference Board's wage studies disclose, is due to the generally smaller output of women rather than to any unwillingness on part of industrial management to pay them the same as men. The fact that earnings per hour of women working on a piecework basis where the basic wage rate is the same as for men, which is the case in many instances, average less than the earnings of the men is cited in evidence. This is also the reason given by many employers for the lower wage rates allowed women where wages are paid on a flat rate basis.

Women, however, have made a relatively larger economic gain in the general rise of the wage level during and since the war than have men, the average hourly wage earnings of women in the manufacturing industries now being approximately 160 per cent higher than in 1914, while those of men have advanced by only about 140 per cent. However, women's hourly earnings in 1914 averaged only 60 per cent of men's.

Women's total earnings over a period of time average less also because women in industry put in less time than men. The average number of hours per week worked by women wage earners during 1927 in 25 manufacturing industries was 43.3, as against 48.2 hours worked by men, with the result that the average weekly earnings of women workers were approximately 40 per cent less than those of the male workers.



TREND IN WOMEN'S OCCUPATIONS IS TOWARD CLERICAL AND PROFESSIONAL CALLINGS

Record Manufacturing Operations During November

The rate of activity in the manufacturing plants of the nation as indicated by the monthly consumption of electrical energy was of record proportions during November, and 17.2 per cent more than in the corresponding month last year, according to reports received from more than 3,600 manufacturing plants by *Electrical World*. All of the primary manufacturing groups, with the exception of leather products and lumber and its products, showed a higher rate of operations than that of November, 1927. Contrasted with October of the current year, general activity increased by 2.2 per cent. With the exception of the Southern states, all sections of the country reported a higher rate of operations than a year ago.

The previous peak of manufacturing operations in 1928 occurred in September, but the November operations were about 0.4 per cent above those of September, after corrections are made for the number of working days. The trend in manufacturing production during the current year is entirely different from that witnessed last year. A distinct downward trend of manufacturing operations was witnessed this time last year, whereas the current trend is upward, despite the unusually high rate of production which has prevailed since last July. There is every reason now to believe that the entire winter season will witness an unusually high rate of industrial activity, materially above that of 1926 or 1927.

This Week's Contracts

Heavy construction contracts, reported by *Engineering News-Record* in the week ended Dec. 11, with some comparisons, total as follows:

(In Thousands of Dollars)

	Dec. 11, 1928	Dec. 4, 1928	Dec. 13, 1927
Buildings:			
Industrial	$4,199	$7,163	$5,021
Commercial	14,677	48,669	33,544
Streets and roads	2,491	12,043	5,076
Other construction	30,420	29,979	15,989
Total	$51,787	$97,854	$59,630
Total, all classes, Jan. 1 to Dec. 11:			
1928			$3,546,896
1927			3,107,941